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Who Is Leading the 5G Patent Race?

2023



Executive Summary

The 5G SEPs (standard essential patents) licensing market is set to become one of the most lucrative, not just in terms of royalties but also for maintaining leadership of increasingly competitive industrial value chains. As a result, the 5G patent race is more competitive than ever, with geopolitical implications as countries vie for technical leadership in critical technologies.

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This race for dominance is reflected in insights from public patent declarations and standards contribution submissions, compiled and detailed in this report. As of July 2023, the number of declared 5G patent families has grown to over 60,000 with about 30,000 patent families granted in Europe or the US, increasing at a rate of about 5,000 patent families annually. During the same time span, the number of 5G patent owners has increased from 32 in 2015 to 131 unique owners. While the top 10 owners control about 76% of all 5G declared patent families, the trend shows that 5G ownership is increasingly fragmented.

Along with outlining these findings, this report ranks the top 50 owners of 5G patent families, revealing Chinese companies account for 32% of all declared 5G patent families (and are 48% of all SEP licensees), a trend that has been increasing over the past eight years. But simply counting 5G patent families is not enough to identify technical leadership. Using patent valuation metrics and standards contribution data analysis together, we get a bigger picture, ultimately enabling us to more accurately rank true 5G leaders.

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Finally, the report shows 5G standards protocols trends that enable new use cases for autonomous driving or IoT applications. Here, the number of NB-IoT declared patents, as well as the number of cellular V2X declared patents, has been sharply increasing at an even higher rate than overall 5G patents.

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5G and the Next Technology Revolution

It's predicted that in the future, half of the world's data will be generated by non-human sources like vehicles, machines, and sensors.[1] With this next "industrial revolution" integrating connectivity more and more into mechanical products, the increasing number of devices and data volumes are placing new demands on 5G and future 6G technologies. Businesses will need to rely on connectivity standards such as 5G that are subject to standard essential patents (SEPs).

> ***It's predicted that in the future, half of the world's data will be generated by non-human sources like vehicles, machines, and sensors.***

A study published by Deloitte[2] reveals that most 5G SEP owners will actively monetize and enforce their portfolios. The study describes that 5G SEP owners, as well as standard implementers, are faced with the challenge to manage operational and financial risks and cost exposures while striving to maximize value. Hence, the 5G technology revolution will not only disrupt business models around connected devices but prompt industries to reconsider how to deal with intellectual property.

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[1] *https://www.ericsson.com/en/reports-and-papers/white-papers/cellular-iot-in-the-5g-era*
[2] *https://www.deloitte.com/global/en/services/financial-advisory/perspectives/navigating5gpatents.html*

How to Determine 5G SEP Royalties

Royalty payments from SEP deals play a crucial role in fueling innovation cycles for connected products. SEP license agreements are achieved when two parties, often with diverse objectives and motivations, reach the end of the process and sign a SEP license contract. To achieve this, companies must find a way to agree on a contract and royalty that will be sustainable for years to come.

SEP portfolios containing thousands of SEPs, which are part of accepted standards like 5G, hold significant value, leading to the question: "How much is a SEP portfolio worth?" The most common approach to determining SEP portfolio value is to rely on comparable license agreements as reference points for other deals. However, these agreements are not public and may not always be comparable.

> ***Valuing SEP portfolios requires assessing both the ultimate owner's 5G portfolio and the overall number of 5G SEPs.***

With the growing complexity of licensing SEPs in new industry verticals beyond smartphones, the need for transparency increases, calling for additional reference points. European Telecommunications Standards Institute (ETSI) offers a database for 3G, 4G, or 5G, serving as a comprehensive list of potentially essential patents. ETSI raw is highly inflated and messy and requires rigorous cleaning, matching and deduplication. However, the most challenging part is assessing the value of these patents and determining which self-declared patents are essential for the standard's implementation. Claim charting seems obvious, but it involves expensive and time-consuming efforts and becomes impractical when negotiating portfolios with hundreds or thousands of patents. Hence, negotiating parties often agree to determine essentiality for smaller samples of larger portfolios. Nonetheless, the question of how large and valuable a given portfolio is compared to the overall number of SEPs for standards like 5G remains.

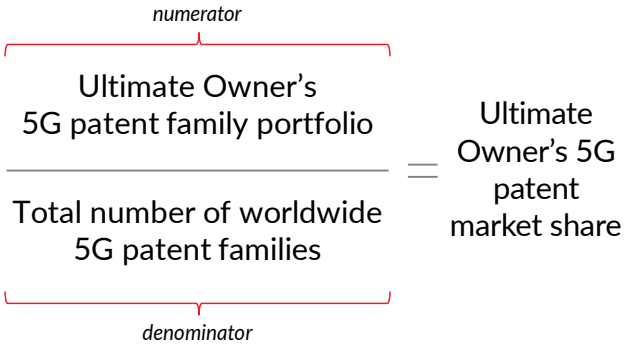


Figure 1: Calculation example to determine an Ultimate Owner's 5G patent market share

Valuing SEP portfolios requires assessing both the ultimate owner's 5G portfolio (numerator) and the overall number of 5G SEPs (denominator) as illustrated in Figure 1. However, with around 60,000 declared 5G patent families (both pending and granted worldwide), it becomes infeasible to value and determine essentialities for all declared patents.

Going Beyond Patent Family Counting: The True Global 5G Leaders

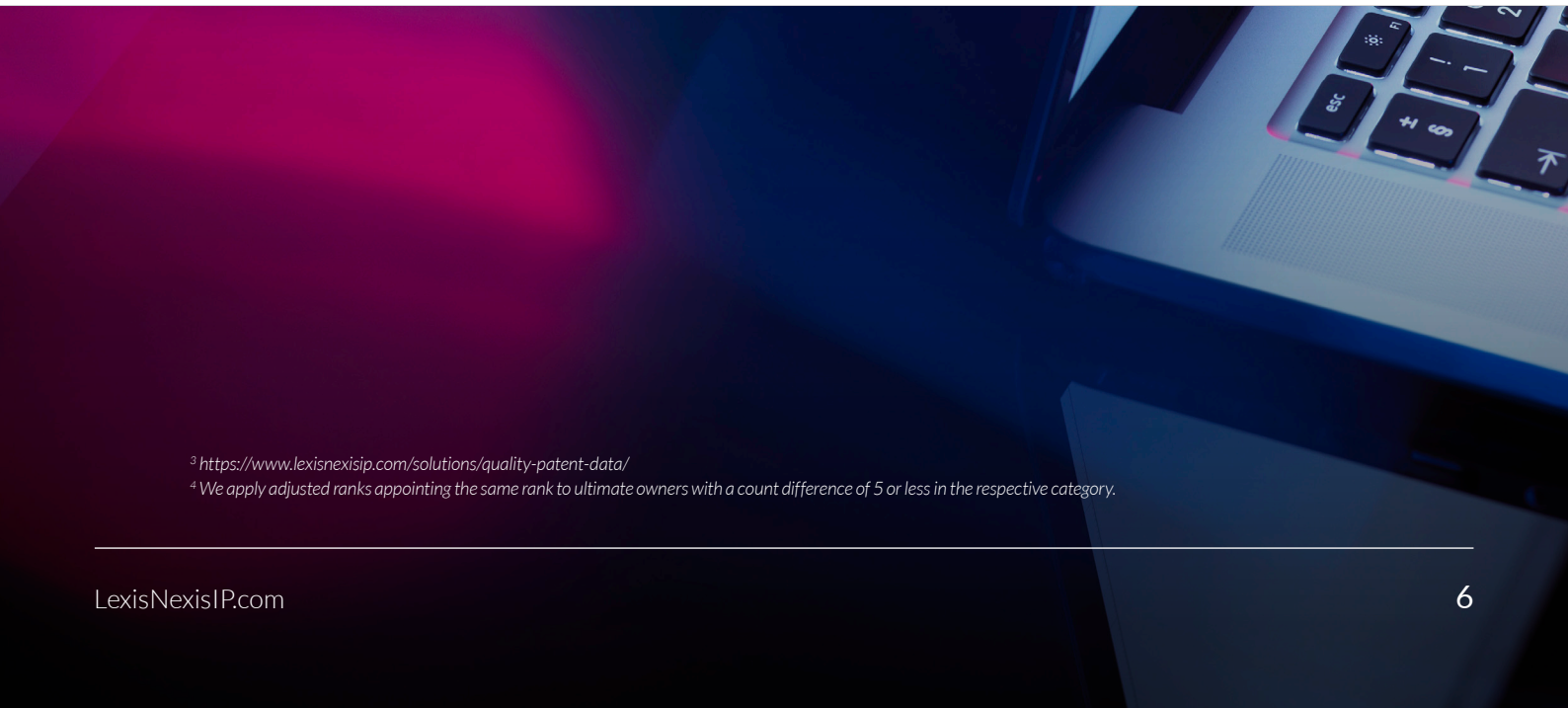
Patents, especially when related to standards, vary in value. SEPs may protect core technologies spanning standards generations but also only minor improvements to existing standards features. Additionally, not all self-declared patents are essential; expert estimates suggest only about 10-20% of declared 5G patents are truly essential. Consequently, counting patents alone doesn't accurately reflect the value and enforceability of a SEP portfolio.

This report collected over 60,000 declared 5G patent families, with about 30,000 active and granted at the EPO or USPTO until July 15, 2023. The identification of 5G patents was done using the 3GPP technical specification (TS) database, mapping ETSI-declared TS to the 5G technology generation and considering 3G to 5G and 4G to 5G bridging technologies. Patents declared to 5G standards projects but declared only to 3G or 4G TS were not considered. Patents were counted according to the ultimate owner data[3], which is the latest assignee and highest parent company, as of July 15, 2023.

The analysis refines the patent count using indicators related to a patent's value and the technical leadership in 5G standard development. Table 1 (Page 7) shows the top 10 companies declaring 5G patents ranked by three different measurements.

The far left column is a ranking of the average across the three measurements.[4] The first measurement ranks ultimate owners by the number of declared 5G patent families (extended INPADOC) that are active and granted (EPO or USPTO). The second column ranks ultimate owners by the number of declared 5G patent families (active, granted, EPO or USPTO) by the Patent Asset Index.

> ***Expert estimates suggest only about 10-20% of declared 5G patents are truly essential.***



[3] *https://www.lexisnexisip.com/solutions/quality-patent-data/*
[4] *We apply adjusted ranks appointing the same rank to ultimate owners with a count difference of 5 or less in the respective category.*

The third column ranks the ultimate owners by the number of technical 5G contributions submitted to the 3GPP—the organization that develops the 5G standard. For this analysis, only technical 3GPP contributions since 2015 are counted (excluding non-technical contributions in categories A, D or F) as these assumingly relate mostly to 5G.

In Table 1, it is evident that relying solely on patent counting can lead to varying results when compared to other indicators of 5G leadership. For instance, **InterDigital**—a company that, different from the other top 10 patent holders—generates profits mainly through SEP licensing, depends heavily on the essentiality and value of its SEP portfolio during negotiations and legal disputes. According to Table 1, **InterDigital** ranks 14th when only patent families (active, granted, EPO or USPTO) are considered. However, when utilizing the Patent Asset Index, **InterDigital** jumps to 5th place in the ultimate owner 5G patent ranking.

Table 1: Ranking of the Top 10 5G patent owners

Rank	Company	HQ	Rank 5G families*	Rank Patent Asset Index 5G families*	Rank 5G relevant 3GPP contributions
1	Huawei	CN	1	3	1
2	Qualcomm	US	2	1	4
3	Samsung	KR	3	2	5
4	Ericsson	SE	6	6	2
5	Nokia	FI	5	7	3
6	LG Electronics	KR	4	4	8
7	ZTE	CN	7	8	6
8	Oppo	CN	7	12	12
9	NTT	JP	10	13	9
10	InterDigital	US	14	5	15

*Active and granted at the EPO or USPTO

CN: China, **US**: United States, **KR**: Korea, **SE**: Sweden, **FI**: Finland, **JP**: Japan

*Go beyond the ranking and gain access to 5G patent owner share data with **LexisNexis® IPlytics** and **LexisNexis® PatentSight®**.*

The Patent Asset Index

The Patent Asset Index represents a measure of the innovative strength of a patent portfolio. A patent family is more valuable when other innovations build on the technology protected by this patent family and by the scope of protection that the ultimate owner considers appropriate. The Patent Assent Index is obtained by multiplying the Technology Relevance (global citations received from later patents adjusted for age, patent office practices and technology field) and the Market Coverage (weighted market size protected by active patents and pending patent applications protecting a certain invention). It is stated relative to the other patent families in the same field. The Patent Asset Index methodology is based on many years of scientific research and has been validated to correlate with a patent's value from the world's biggest patent holders across industries.

Prominent use cases include the usage of LexisNexis® PatentSight® and the Patent Asset Index by the European Commission DG Competition to drive M&A decisions such as Dow-DuPont and Bayer-Monsanto. Further, it is regularly used by large operating companies to communicate their innovative strength in investor communication.

3GPP

Standards developing organizations (SDOs) are contribution based, which means that member companies submit technical proposals for inclusion in the standard. Alternative solutions are then proposed by other members. These competing proposals are either rejected or approved in a consensus decision making process. Approved contributions are typically followed by suggestions for improvements or changes, which are then voted on. The resulting final specifications are therefore reviewed by hundreds of global experts. The experts usually work for companies that are competitors in the market. SDOs are thus both collaborative and highly competitive.

The 5G standard is specified by the 3GPP (3rd Generation Partnership Project) which is an umbrella organization developing the protocols for the mobile telecommunications generations 3G, 4G and 5G that are published by ETSI (European Telecommunications Standards Institute). Also, the 3GPP follows the principle of consensus decision making. Consequently, it requires considerable research and investment to make technically meaningful and convincing contributions that are accepted, approved and incorporated by all members (if consensus is not reached, some decisions also follow majority voting procedures). Companies can only gain credibility by regularly participating and developing the best specifications, which allows them to bring their own developed and sometimes patented technologies into the standard. 5G contribution data, therefore, facilitates assessment of the involvement and investment of companies in the development of 5G standards.

Table 2 shows the ranks for the top 11-50 5G patent owners. **Apple** has secured a strong position in the top 11-20 ranking, coming in at 9th place when considering the Patent Asset Index. Additionally, **Foxconn**, which owns the former Sharp portfolio, and **MediaTek** also have strong Patent Asset Index rankings.

Table 2: Ranking of the Top 11-30 5G patent owners

Rank	Company	HQ	Rank 5G families*	Rank Patent Asset Index 5G families*	Rank 5G relevant 3GPP contributions
11	MediaTek	TW	13	11	11
12	Apple	US	11	9	16
13	Lenovo	CN	17	15	14
13	Foxconn	TW	9	10	27
15	Vivo	CN	17	20	10
16	Intel	US	20	21	7
17	Xiaomi	CN	15	17	19
18	NEC	JP	16	18	18
19	Sony	JP	19	19	22
20	ETRI	KR	22	22	25
21	CICT Mobile**	CN	12	14	46
22	AsusTek	TW	22	15	39
23	Panasonic	JP	26	27	28
24	Fujitsu	JP	25	29	32
25	KT Corporation	KR	30	27	33
26	BlackBerry	CA	34	23	34
26	Alphabet	US	27	23	41
28	HTC Corporation	TW	21	26	50
29	ITRI	TW	27	34	37
30	Philips	NL	32	30	43

*Active and granted at the EPO or USPTO

TW: Taiwan, **US**: United States, **CN**: China, **JP**: Japan, **KR**: Korea, **CA**: Canada, **NL**: Netherlands

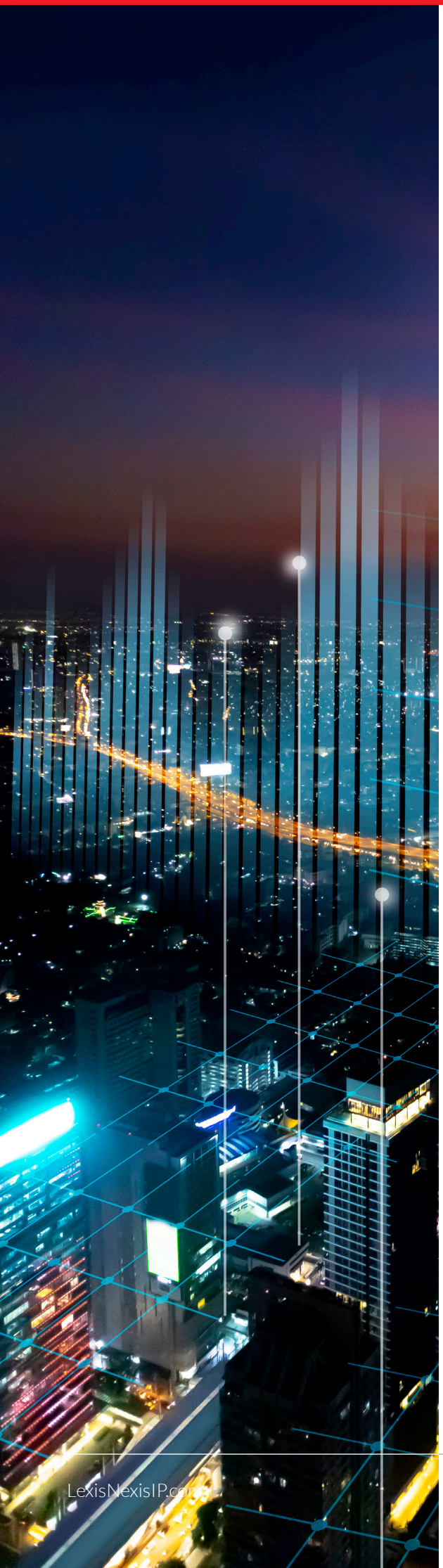
***CICT Mobile spun off from CICT Group in 2022. Patents filed by CATT, a CICT Group subsidiary, had been reassigned to CICT Mobile in public registers. However, CATT has remained as a CICT Group subsidiary. Therefore, those contributions are not shown with CICT Mobile in this report. CICT Group ranks as #8 in terms of 5G relevant 3GPP contributions.*

Table 2: Ranking of the Top 31-50 5G patent owners

Rank	Company	HQ	Rank 5G families*	Rank Patent Asset Index 5G families*	Rank 5G relevant 3GPP contributions
31	Unisoc	CN	38	44	26
32	Kyocera	JP	27	36	47
33	Fraunhofer	DE	41	37	36
34	Deutsche Telekom	DE	41	53	21
35	Mitsubishi Electric	JP	35	32	49
36	KPN	NL	45	47	30
36	Coolpad	CN	35	34	53
38	Key Patent Innovations	IRL	31	25	69
39	Langbo	CN	24	40	63
40	Cisco	US	56	45	30
41	Wilus	KR	45	37	51
42	Shenzhen Zhixin	CN	32	37	67
43	Sun Patent Trust	US	41	31	69
44	Advanced Standard Communication	US	35	41	69
45	Brevet Capital	US	45	33	69
46	Orange	FR	56	74	20
46	TCL	CN	49	56	45
48	Innovative Sonic	TW	41	43	69
49	SK Telecom	KR	56	60	38
50	Longhorn IP	US	45	42	69

*Active and granted at the EPO or USPTO

CN: China, **JP**: Japan, **DE**: Germany, **IE**: Ireland, **NL**: Netherlands, **US**: United States, **KR**: Korea, **FR**: France, **TW**: Taiwan



Considerations for Interpreting 5G Patent Rankings

Examining 5G patent rankings requires caution due to data limitations and varying filters. ETSI's patent declaration data lacks essentiality confirmation and isn't cleaned or updated. Different declaration practices among 5G patent owners affect rankings. Over-declaration is common due to ETSI's early declaration policy, and data refinement is crucial. 3GPP contribution data is similarly inflated, including non-technical contributions.

In this report, we implement data refinement methods recommended by experts.[5] We count unique patent families, deduplicate across specifications, expand family counterparts, delete falsely declared patents and even rank 5G portfolios excluding earlier-generation patents to cross-check the results. This way we eliminate intentional over declaration practices that may inflate results. For contribution data we also deduplicate and only consider technical contributions.

Remember, SEP licensing involves complex negotiations. Cleaned and curated patent declaration data can serve as one reference point among others, including details on past contracts, comparable license agreements, claim charts, subject matter expert testimony and more.

[5] *https://www.qualcomm.com/news/onq/2023/08/how-companies-game-the-etsi-sep-database-to-manipulate-perceptions-of-leadership-in-5g*

Better Understanding the 5G Leaders

Table 1 and 2 present the top 50 5G ultimate owners, reflecting the aggregation of patent ownership to the highest parent company. Some names in the table represent the highest parent company and not the well-known subsidiary patent owner. The **NTT** 5G portfolio was filed by its subsidiary **NTT DOCOMO**. **Foxconn**, as the controlling shareholder of **Sharp** integrates the 5G **Sharp** portfolio. The Chinese technology conglomerate **CICT Mobile** integrates the **Datang Mobile** 5G portfolio. **Shenzhen Zhixin** integrates the Honor Device 5G portfolio, however most of the patents were originally filed by **Huawei**, now owned by **Honor Device**.

The list of top 50 ultimate owners of 5G patents has a diverse range of companies, both in terms of location and business models. Table 3 shows that the top 50 ranking is dominated by Chinese companies followed by US and European companies.

Table 3: Number of 5G ultimate patent owners in Top 50 ranking by region

HQ	Number of ultimate owners in Top 50 5G p atent ranking
CN	12
US	10
JP	7
KR	6
TW	6
NL	2
DE	2
SE	1
FI	1
FR	1
CA	1
IE	1
Total	50

CN: China, **US**: United States, **JP**: Japan, **KR**: Korea, **TW**: Taiwan, **NL**: Netherlands, **DE**: Germany, **SE**: Sweden, **FI**: Finland, **FR**: France, **CA**: Canada, **IE**: Ireland

The top 50 ranking is dominated by Chinese companies, followed by US and European companies.

Most ultimate owners of 5G patents are handset, cellular infrastructure, chip or telecommunications manufacturers. However, licensing 5G SEPs is a lucrative market, attracting Patent Assertion Entities (PAEs) among the top 5G patent owners. Although non-practicing, some PAEs, have in-house R&D and a 5G patent filing practice. On the other hand, PAEs like **Key Patent Innovations Limited** acquire SEP portfolios from larger SEP owners to assert them against standards implementers. **Key Patent Innovations Limited** has also publicly announced its acquisition of **BlackBerry** SEPs.[6]

Brevet Capital is the parent company of **Unwired Planet** and **Optis Wireless**, holding a considerable 5G portfolio acquired from **Ericsson**, **Panasonic**, **Samsung** and **LG**. **Longhorn IP** acquired its 5G patents from **ZTE**, **FG Innovation** and **Shanghai Langbo**. Sun Patent Trust acquired Panasonic's 5G portfolio, while **Advanced Standard Communications** obtained its 5G patent portfolio from **ZTE**.

Licensing 5G SEPs is a lucrative market, attracting research-focused organizations as well as Patent Assertion Entities (PAEs) among the top 5G patent owners.



[6] *https://www.blackberry.com/us/en/company/newsroom/press-releases/2023/blackberry-announces-new-patent-sale-transaction-with-leading-patent-monetization-company-for-up-to-900-million*

5G Patent Trends

Trend #1: *The number of companies owning 5G patents continues to increase year-over-year.*

The relevance of 5G technology has been drastically increasing across industries, resulting in more and more companies building 5G patent portfolios. Figure 2 shows that the number of ultimate owners of 5G patents has been increasing year-over-year to 131 unique worldwide ultimate owners (highest parent company)[7] with at least two active and granted EPO or USPTO patent families.

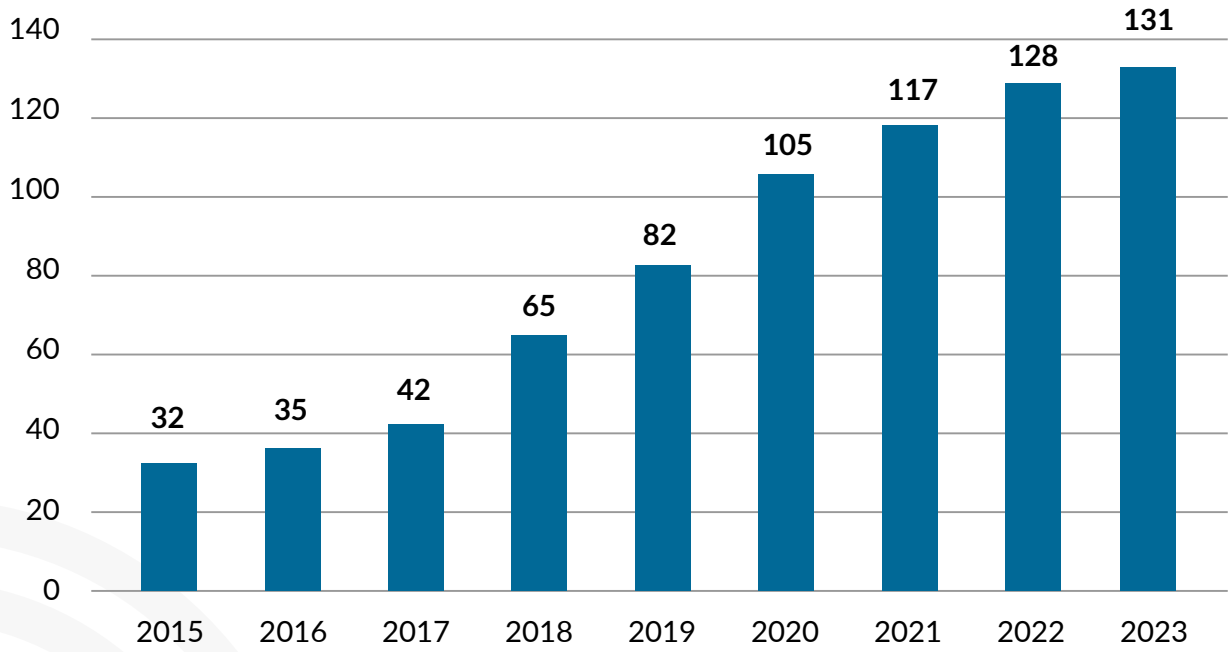


Figure 2: Number of 5G patent family-owning companies with at least 2 granted and active EPO or USPTO-declared patent families by year of declaration and year of patent family grant.

[7] *https://help.lexisnexisip.com/s/article/Data-Harmonization-and-Ownership-Information*

Trend #2: *The majority of 5G patent families are owned by the top 10 5G companies.*

While the number of ultimate owners of 5G patents has been constantly increasing, the majority of 5G patent families are owned by the top 10 5G ultimate owners. Figure 3 illustrates the top 10 5G ultimate owner share over the past eight years. While the top 10 share peaked at 84.34% in 2019, the share has been decreasing in recent years, down to about 76% in 2023, while the rate of standards contributions by the top 10 remained at the same level. While there is a clear trend that 5G patent ownership becomes more fragmented, 5G patent ownership is still highly concentrated.

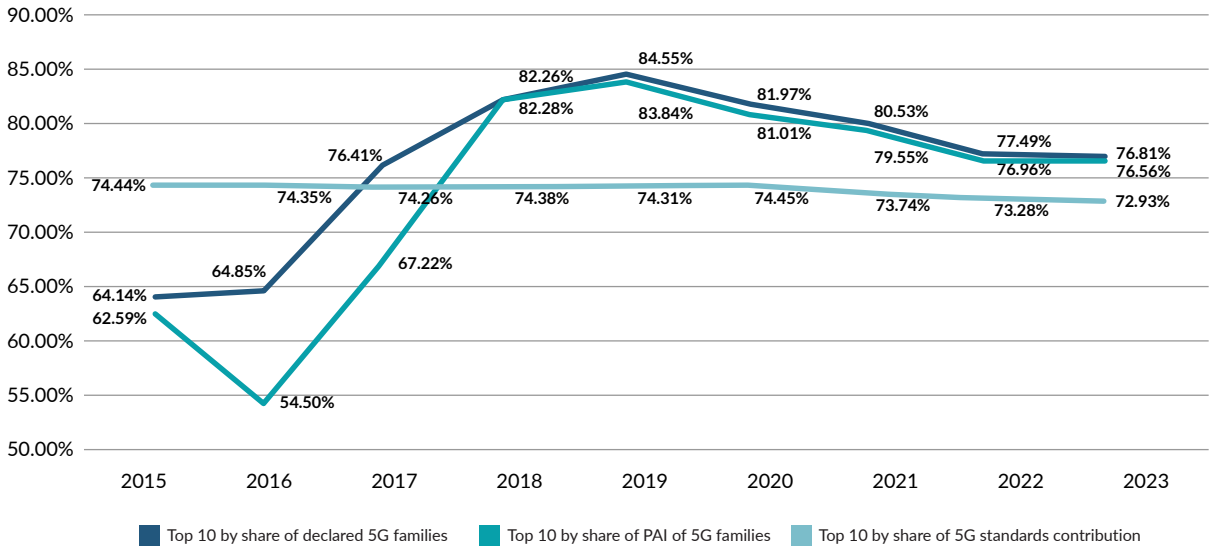


Figure 3: Patent family share of the top 10 SEP-owning companies by year of declaration and year of patent family grant (EPO or USPTO), by share of declared 5G families, by share of Patent Asset Index of 5G families, by share of 5G standard contributions.



Trend #3: *The number of declared 5G families has increased at a rate that is 2.5x more than what was declared for 4G.*

Compared to earlier generations 5G allows faster data speeds, lower latency, increased capacity such as massive MIMO (Multiple Input, Multiple Output), improved spectral efficiency and introduces new concepts like network slicing or beamforming. Consequently, 5G is a much more complex technology compared to the 3G or 4G generations and Figure 4 also confirms that the number of declared 5G families has increased tenfold between 2017 and 2023, reaching over 60,000, which is almost 2.5x more than the 24,000 patent families declared for 4G.

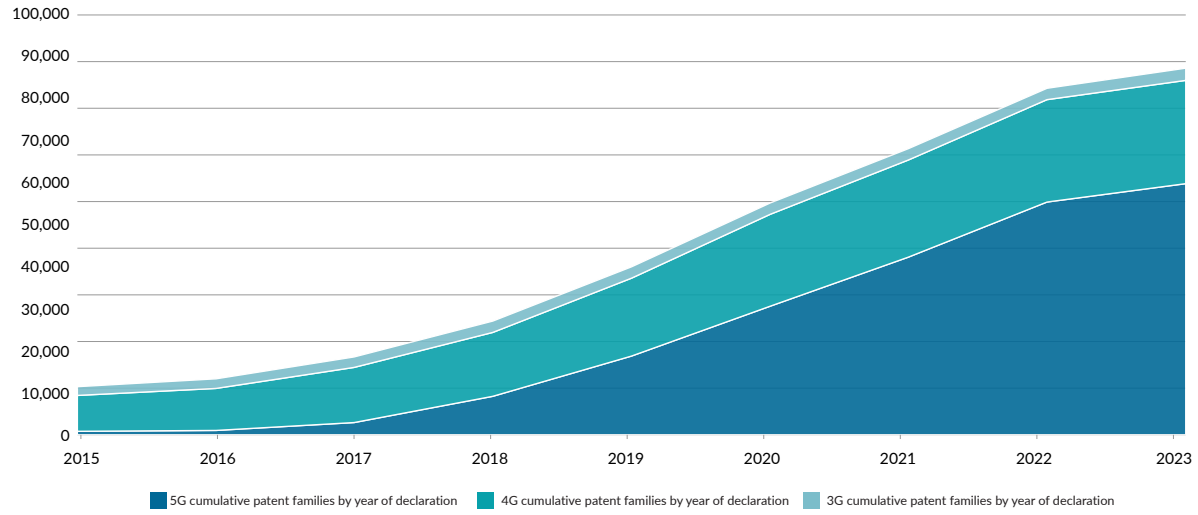
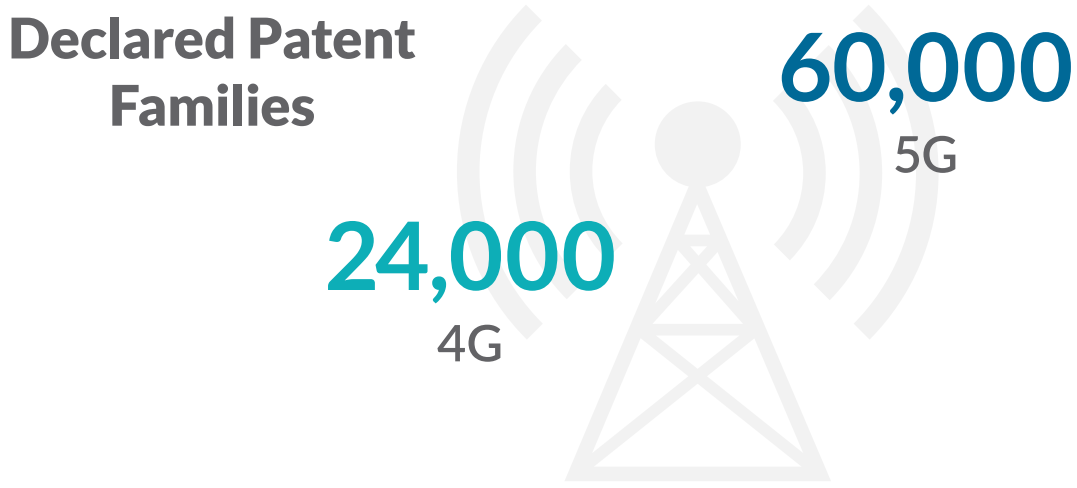


Figure 4: Cumulative number of active (not lapsed nor expired) 3G, 4G and 5G declared patent families by year of declaration (Note: Patent families declared to more than one generation were counted for each generation; therefore, counts are only unique by generation.)



Trend #4: *There is global growth in the number of active and granted 5G patent families, with the US and China leading in volume.*

Figure 5 shows the cumulative number of active (not lapsed, not expired) and granted 5G patent families by jurisdiction and by year of patent grant. Families granted across jurisdictions were counted for each jurisdiction. Overall, the number of granted 5G patent families across the US, China, Europe, South Korea, and Japan is about 41,000 granted patent families. The US is the leading jurisdiction with over 28,000 granted 5G families, followed by China with about 26,000 granted 5G patent families and Europe with about 15,000 granted 5G patent families.

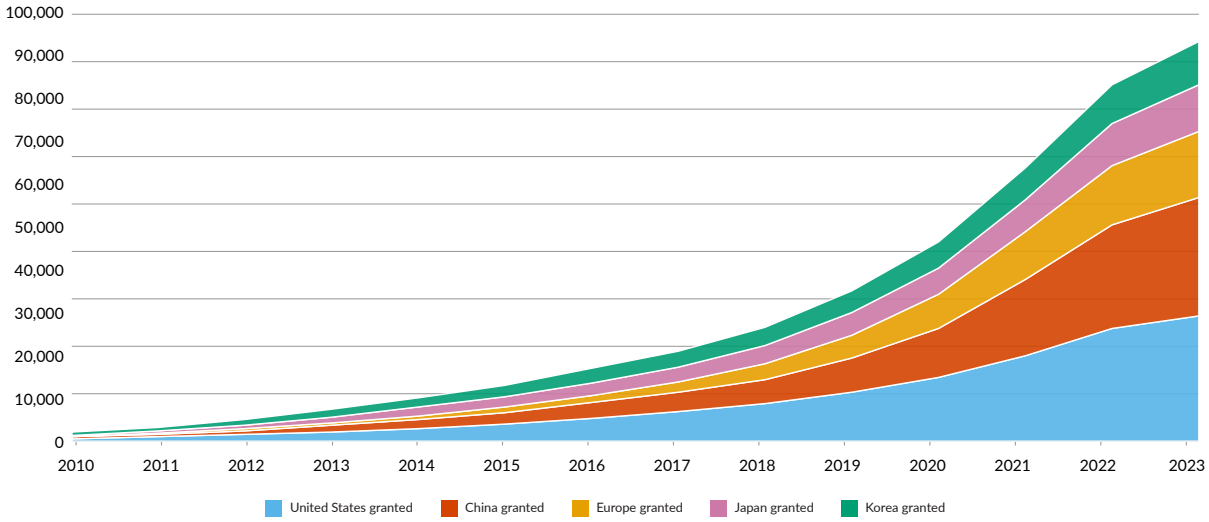
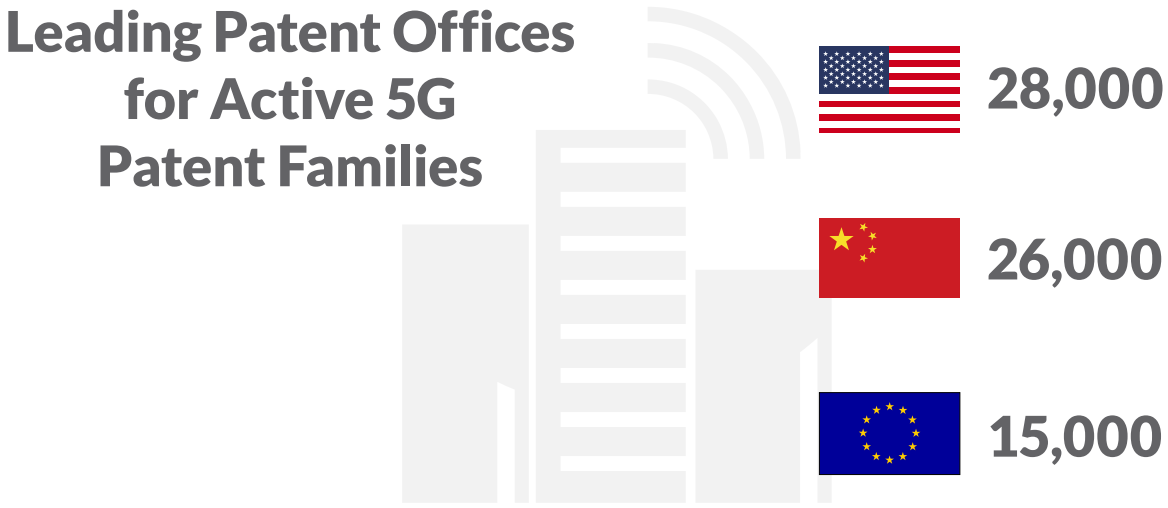


Figure 5: Cumulative number of active (not lapsed nor expired) and granted 5G patent families by jurisdiction and by year of grant.



Trend #5: *There has been a significant increase in technical contributions sent to standards organizations such as 3GPP, leading them to impose submission limitations.*

The 3GPP standards organization is responsible for 5G standardization, building upon its successful work with 3G and 4G standards. The development of 5G standards began in 2015. 3GPP operates on a contribution-based model, where member companies submit technical proposals for inclusion in the standard. Figure 6 shows the significant increase in technical 3GPP contributions since 2015, reaching over 940,000 cumulative contributions by 2023. On average, almost 80,000 new technical contributions are submitted each year, with approximately 80% associated with 5G technology. This growing interest in 5G has led 3GPP to impose limitations on the number of contributions that are allowed to be submitted per meeting in 2017. This rise in standards contributions correlates with the increasing number of 5G patent declarations, indicating heightened efforts in 5G standards development.

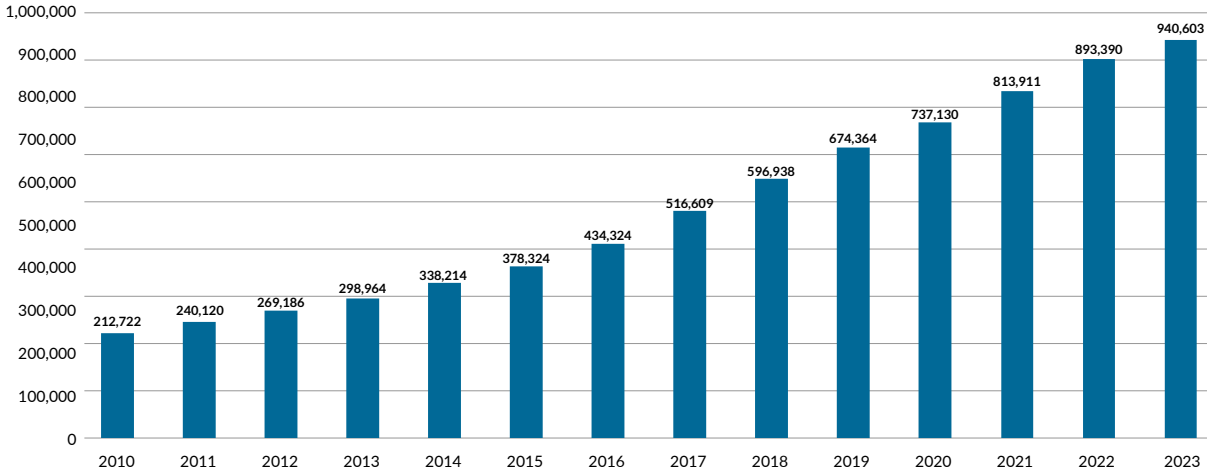
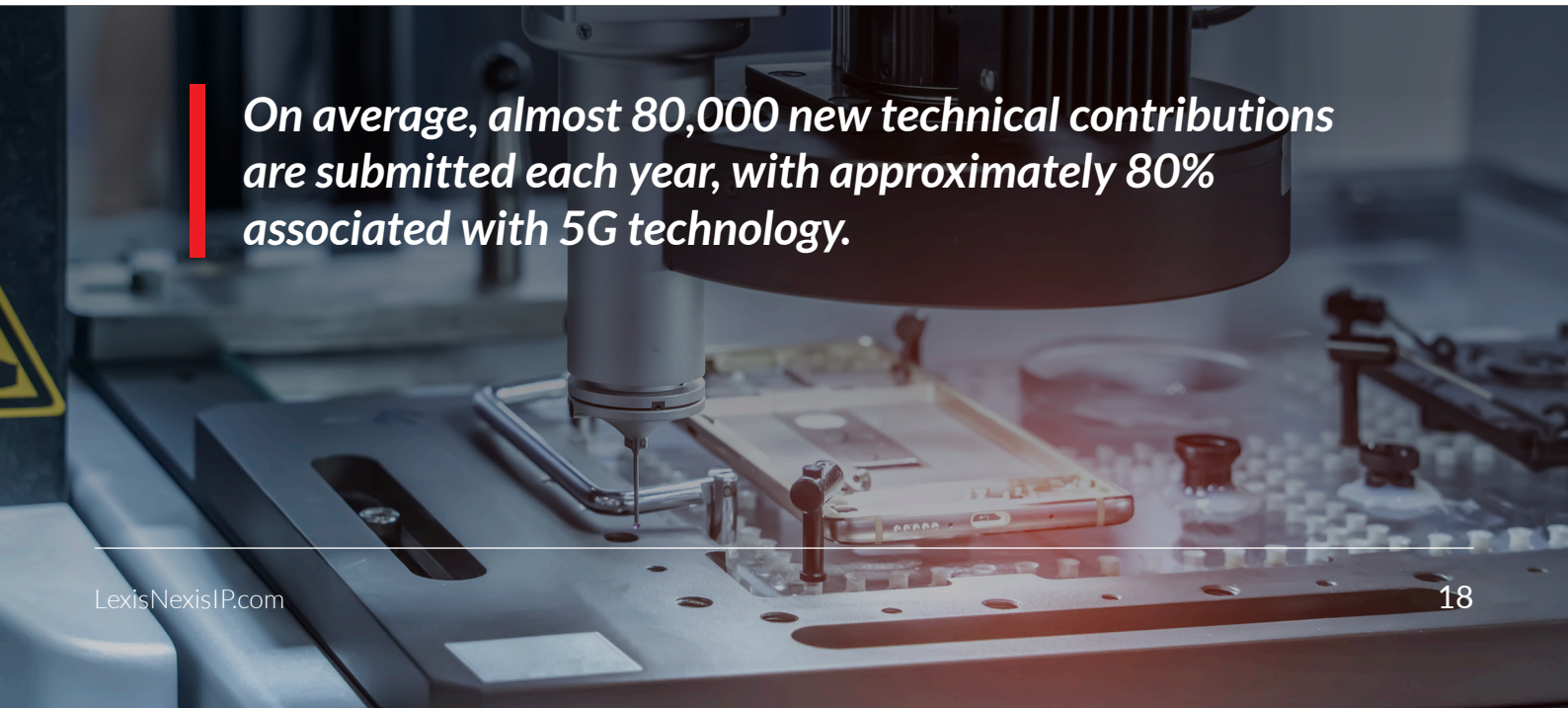


Figure 6: Cumulative number of technical standards contributions by year



Trend #6: *While growing their 5G patent portfolios, the US, Korea and China have maintained above-average portfolio strength compared to other regions.*

When we look at the development of the declared 5G patent portfolios by headquarter region from 2015 through 2023 in Figure 7, several data points are noteworthy. Portfolios controlled by companies headquartered in the United States had the highest average Patent Asset Index (y-axis) since 2015. Combined with a strong growth in number of active INPADOC families, this has resulted also in the strongest overall portfolio strength (Patent Asset Index, bubble area). Note that the US portfolios have started out on a very high average on the y-axis, which is about 11x higher than the PatentSight database average of 1 and have remained well above the other large portfolios.

While a lot of attention is typically given to Chinese companies for growing their portfolios in the 5G space, one could easily overlook the importance of Korea. In terms of overall Patent Asset Index (bubble area), Korea (2nd) and China (3rd) have shown strong growth in overall size of the portfolio (x-axis) while continuing to deliver a high average Patent Asset Index (y-axis).

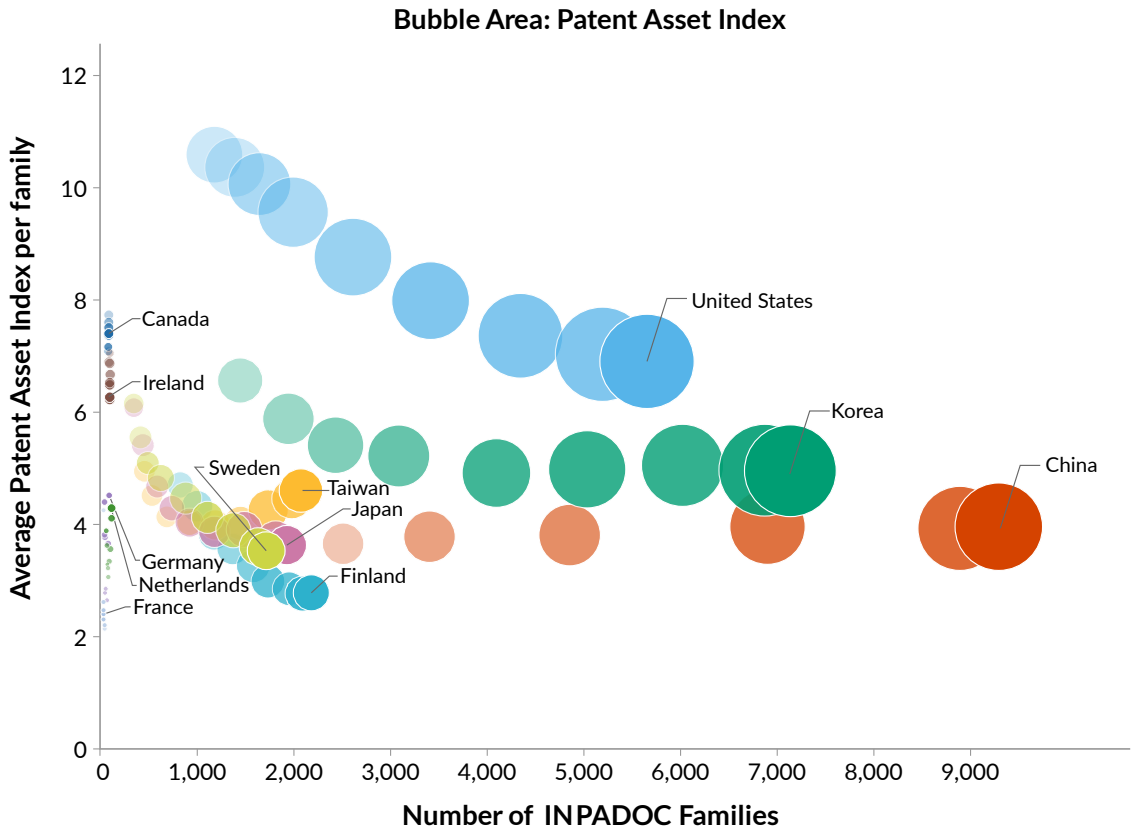


Figure 7: Development of portfolios between Reporting Date 2015 and 2023 by headquarter region of ultimate owner.

SEP Licensing Across Geographies

SEP licensing involves reaching an agreement on royalty rates, considering vast portfolios of SEPs covering multiple generations of wireless technology. Different industries have varying approaches to SEP licensing, with no one-size-fits-all solution. The AVANCI platform[8] has been established to license 2G, 3G and 4G SEPs to automotive OEMs and an AVANCI 5G program[9] just launched this year. One of Sisvel's patent pools[10] offers cellular 4G and 5G IoT SEPs similar to AVANCI's IoT program[11], as well as a 5G multimode program to the consumer electronics market. 5G SEP licensing for handsets, however, is mostly driven by bilateral licensing agreements and here many 5G deals are updates of earlier 4G SEP agreements.

Figure 8a (Page 21) shows the 5G patent family share (EPO or USPTO granted) by the region of the 5G-owning companies' headquarters. Figure 8b in comparison shows the share of the number of 5G-owning companies (owning at least 10 EPO or USPTO-granted patent families) by the headquarters' region. The trends show that Chinese companies' share of 5G patent families has constantly increased and is the highest in 2023 just above 32%, followed by Korean, US and European companies. The results of Figure 8b show that US companies are in the lead, when counting the number of companies with at least 10 5G patent families, with European and Korean companies a few percentages behind. When comparing Figure 8a (considering the 5G patent share by its owner's headquarter) and Figure 8b (considering the number of 5G ultimate owners by headquarter) the spike in the share increase of Korean companies in 2018 is much stronger in 8a. This shows that the increase is not triggered by new Korean players that entered the market but due to the increasing declaration of known 5G ultimate owners.

There is no one-size-fits-all solution to SEP licensing, and different industries have varying approaches.



[8] *https://www.avanci.com/vehicle/4g/*
[9] *https://www.avanci.com/vehicle/5g/*
[10] *https://www.sisvel.com/licensing-programs/wireless-communications/cellular-iot/introduction*
[11] *https://www.avanci.com/iot/smart-meters/*

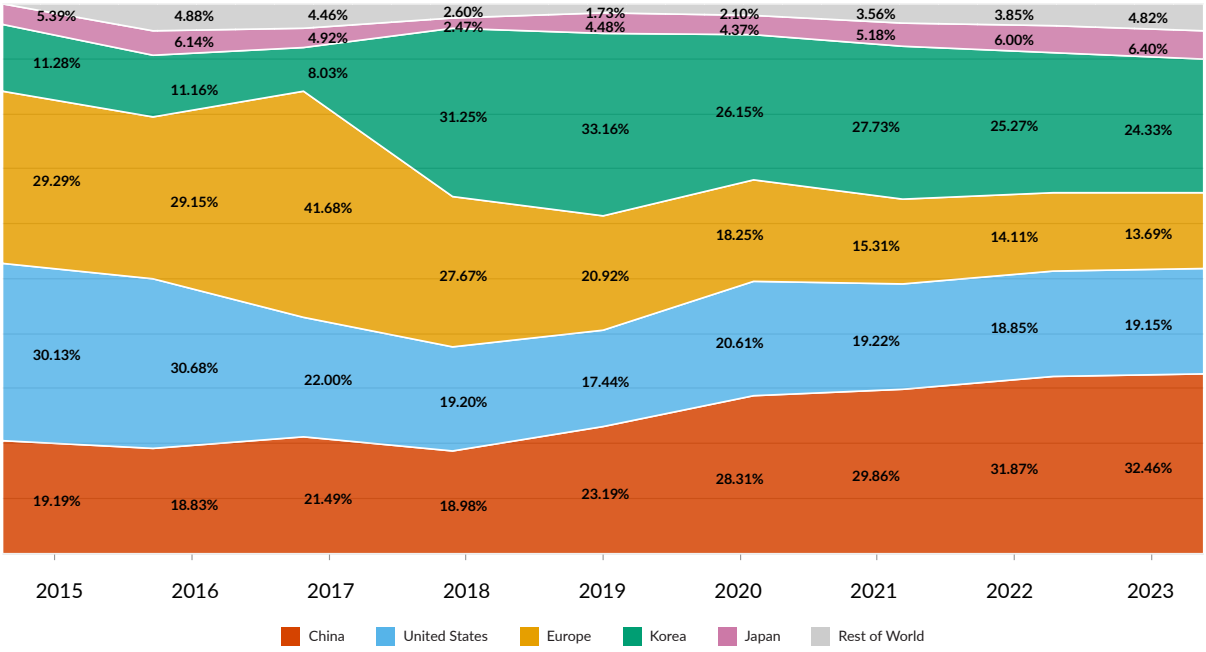


Figure 8a: 5G patent family (EPO or USPTO granted) share by the headquarter region of 5G-owning companies.

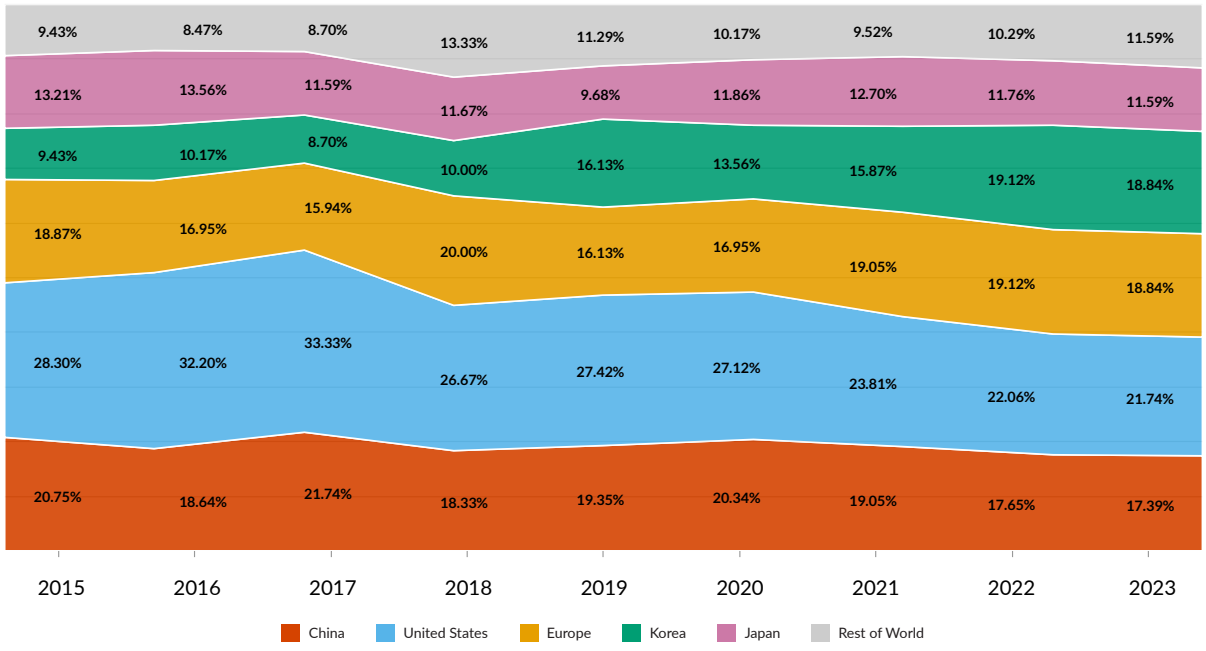


Figure 8b: Share of the number of 5G-owning companies (owning at least 10 EPO or USPTO-granted patent families) by the region of headquarter

To compare the licensor with the licensee market, Figure 9 shows the number of 3G, 4G and 5G SEP licensees by their headquarters' region. In total we identified around 500 licensees that were listed as licensees at cellular patent pool programs or public SEP licensee lists.[12] Note that bilateral SEP licensing contracts are not all public hence the list of licensees may not be complete. The data shows that most licensees are Chinese followed by European and US companies. When only counting the number of companies by region of headquarter Chinese companies only make up just above 17% of all 5G licensors while, the licensee number with 48% is much higher which makes China a region of net-licensees. Not shown in Figure 7, but when looking at other characteristics of these licensees, we see organizations of all sizes from the smartphone industry, automotive companies like OEMs and suppliers, also household appliances, semiconductors, building technologies and many others. To put it differently: licensees range from a broad variety of industries and company sizes. For any given company that is still considering the application of 5G in its products or services, the likelihood is very high that players in their ecosystem are already taking advantage of the opportunities of interconnectivity.

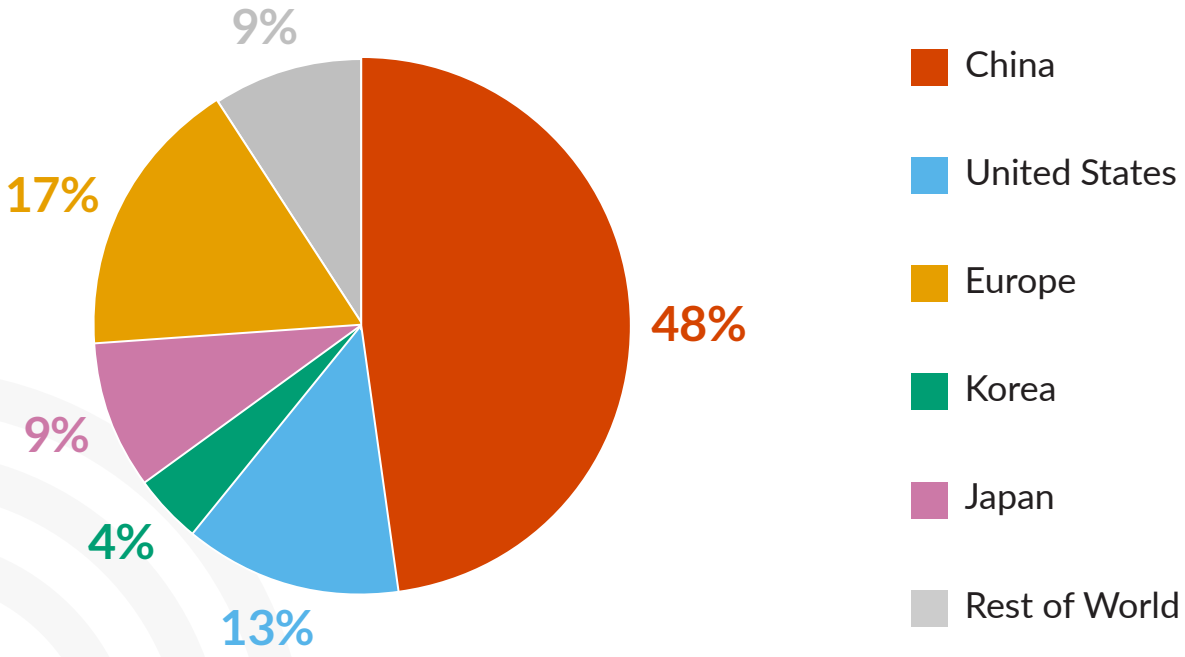


Figure 9: Region of headquarter by the number of 3G, 4G and 5G licensees

[12] *https://www.qualcomm.com/licensing?#licensee-search*

The Impact of Cellular IoT Protocols

The upcoming industrial revolution will have a significant impact beyond smartphones and computers, extending to various sectors such as automotive, manufacturing, energy, healthcare, and MedTech. These industries, with their networked high-value equipment and massive data needs, are likely to benefit from connectivity advancements, particularly through standards such as 5G. These standards will enable remote control, monitoring, repair, and automation in industrial machinery and robots, as well as smart grids, drone control, and other energy and utility applications.

Connectivity standards will also play a crucial role in the healthcare industry, facilitating data exchange between various tablets, fixed machines, and enabling remote surgeries. Industries as diverse as agriculture and finance are expected to benefit from enhanced monitoring and automation. Meanwhile, online shops will increasingly leverage virtual reality experiences, and the logistics sector will see the emergence of 5G-based tracking. Edge computing and low latency of 5G will be used in the gaming business, as well as in general augmented and virtual reality applications. As transportation operators rely on connectivity standards to connect smart city infrastructure, media companies will boost mobile streaming speeds and quality.



Challenges exist in ensuring efficient wireless communication between numerous sensors and the network, with a focus on energy-efficient transmission technology. 5G massive machine type communication (mMTC) is anticipated to address these challenges, allowing the connection of up to 1 million devices per km2. Additionally, low-power wide-area (LPWA) technologies like narrowband IoT (NB-IoT) and LTE-M have been developed to cater to applications with low bandwidth requirements and power consumption. Protocols introduced by 3GPP in 2015 specified how NB-IoT and LTE-M transmissions will be incorporated directly into 5G NR deployments. With the launch of the Sisvel Cellular IoT patent pool[13], the first SEP licensing program for NB-IoT and LTE-M will be established.

Figure 10 counts the cumulative number of NB-IoT, LTE-M and LTE-Cat1 declared patent families by year of publication (pending as well as granted considering all jurisdictions). NB-IoT, LTE-M and LTE-Cat1 are technology protocols specified in a defined list of technical specifications (TS). Searching these lists of technical specifications (TS)[14] allows identifying potentially essential patent families that have been declared to NB-IoT, LTE-M and LTE-Cat1 specifications across 4G and 5G standards generations. The data shows that NB-IoT has the largest number of patent families with a sharp increase over the past 10 years to almost 20,000 declared patent families, followed by LTE-M and LTE-Cat 1. Among the strongest owners of NB-IoT declared patent portfolios are **Huawei** (CN), **Samsung** (KR), **ZTE** (CN), **Qualcomm** (US) and **Nokia** (FI).

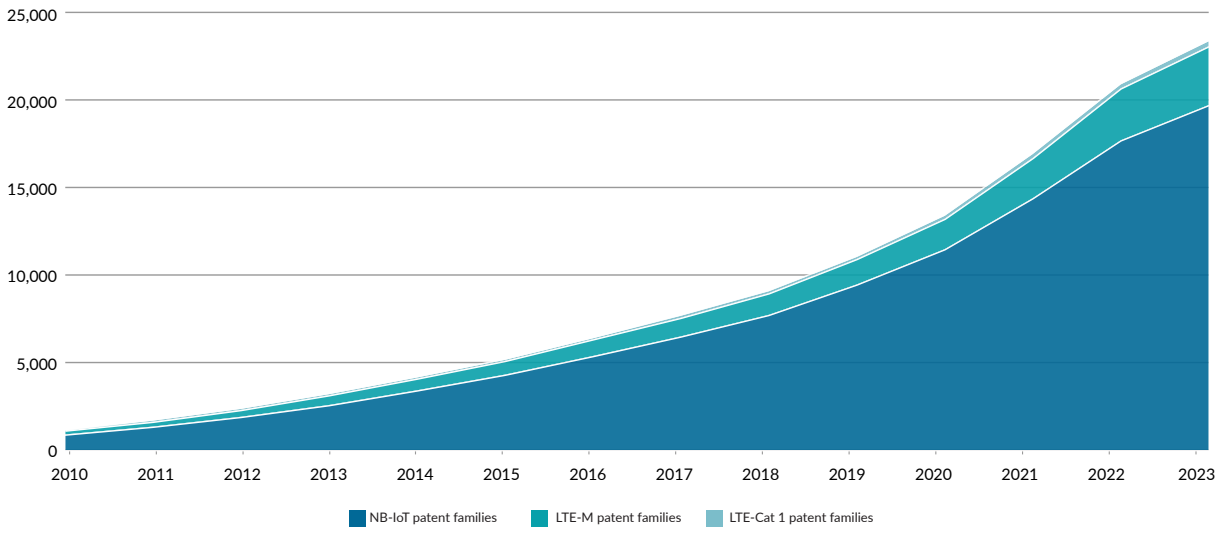


Figure 10: Cumulative number of NB-IoT, LTE-M and LTE-Cat1 declared patent family by year of publication

[13] *https://www.sisvel.com/licensing-programs/wireless-communications/cellular-iot/introduction*

[14] *Using the technical specifications (TS) a patent was declared to for identifying NB-IoT, LTE-M and CAT1 patents is only the first approach. For a more granual analysis one must only consider certain sections of the relevant TS that relate to e.g. NB-IoT while other sections of the same TS may not be NB-IoT relvant.*

The Impact of Cellular V2X Protocols

Autonomous vehicles are projected to generate around 4,000 GB (4 terabytes) of data daily, assuming only one hour of driving. For more heavily used vehicles, the estimate increases to around 40,000 GB (40 terabytes) of data for every eight hours of driving time. In comparison, the global monthly average smartphone usage is anticipated to be at only 19 GB in 2023, potentially reaching no more than 46 GB by the end of 2028.

Cellular V2X (C-V2X) employs 4G and 5G connectivity for vehicle-to-vehicle, vehicle-to-pedestrian, and vehicle-to-traffic control messaging. 3GPP Releases 14, 15, and 16 introduced C-V2X specifications, including 5G NR for direct V2V/V2I communication. C-V2X is a technology protocol specified in a defined list of technical specifications. Searching these lists allows for identifying potentially essential patent families that have been declared across 4G and 5G C-V2X standards specifications.

Figure 11 counts the cumulative number of C-V2X declared patent families by year of publication (pending as well as granted considering all jurisdictions). The data shows that V2X is supported by numerous 4G and 5G patent families, exhibiting exponential growth over the past three years. Among the strongest owners of V2X declared patent portfolios are **Huawei** (CN), **ZTE** (CN), **LG** (KR), **Samsung** (KR) and **Qualcomm** (US).

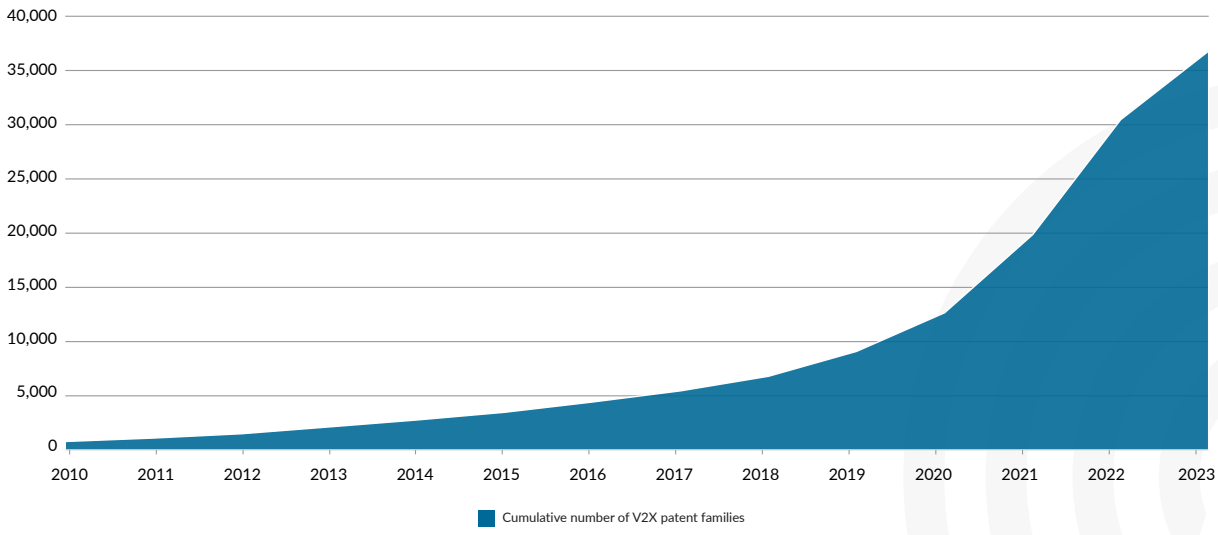


Figure 11: Cumulative number C-V2X declared patent family by year of publication

The Industries Poised for 5G Disruption

Companies embracing standards like 5G, which involve numerous SEPs, should adopt a proactive approach to manage operational risk and costs, rather than a reactive one. However, many businesses in emerging industry sectors that already adopt standards subject to SEPs lack experience in negotiating SEP licenses. Despite the complexity, understanding the overall SEP landscape is essential for seamless standard adoption, sustained profitability, and safeguarding the ability to offer new products and services while accessing third-party patent rights.

Smart Vehicles

The automotive industry leads in adopting connectivity standards like 4G or 5G, connecting vehicles to other vehicles, devices and infrastructure. Transport will leverage connectivity for dynamic traffic management, intelligent parking and autonomous vehicle integration. While fully autonomous vehicles are likely to develop gradually, manufacturers are already implementing autonomous functions (eg, speed control and lane departure warning). Current automotive connectivity focuses on automatic emergency calls (e.g., eCall), smartphone signal enhancements, telematics and navigation. However, in the future, vehicles will increasingly rely on connectivity technologies for complex traffic situations. Similar to mobile phones shifting from feature to smartphones, the auto industry will likely undergo comparable shifts in business models and profit distribution among market players and platforms.

In the future, vehicles will increasingly rely on connectivity technologies for complex traffic situations. Similar to mobile phones shifting from feature to smartphones, the auto industry will likely undergo comparable shifts in business models and profit distribution among market players and platforms.



In 2023, Avanci launched its new 5G Connected Vehicle Program. The program boasted 58 SEP licensors, with **Mercedes-Benz** as the first named licensee, and welcomed **Huawei** as a new addition. Huawei is known for being a large cellular SEP holder and supplier for the auto industry. Previously, **Huawei** had its own SEP licensing program and also licensed bilaterally to vehicle OEMs and tier 1 suppliers. According to the analysis based on patents declared across all standards generation 2G-5G using INPADOC family counts by ultimate owners, the Avanci 5G Vehicle program accounts for approximately 80% of all 2G-5G active patents. When considering patents active and granted in at least one of the IP5 jurisdictions, the share rises to 83%. Furthermore, when weighting patent family counts by the Patent Assent Index, the Avanci 5G Vehicle program's share is even higher and above 85%.

The Avanci 5G Vehicle program accounts for approximately 80-85% of all 2G-5G active patents.

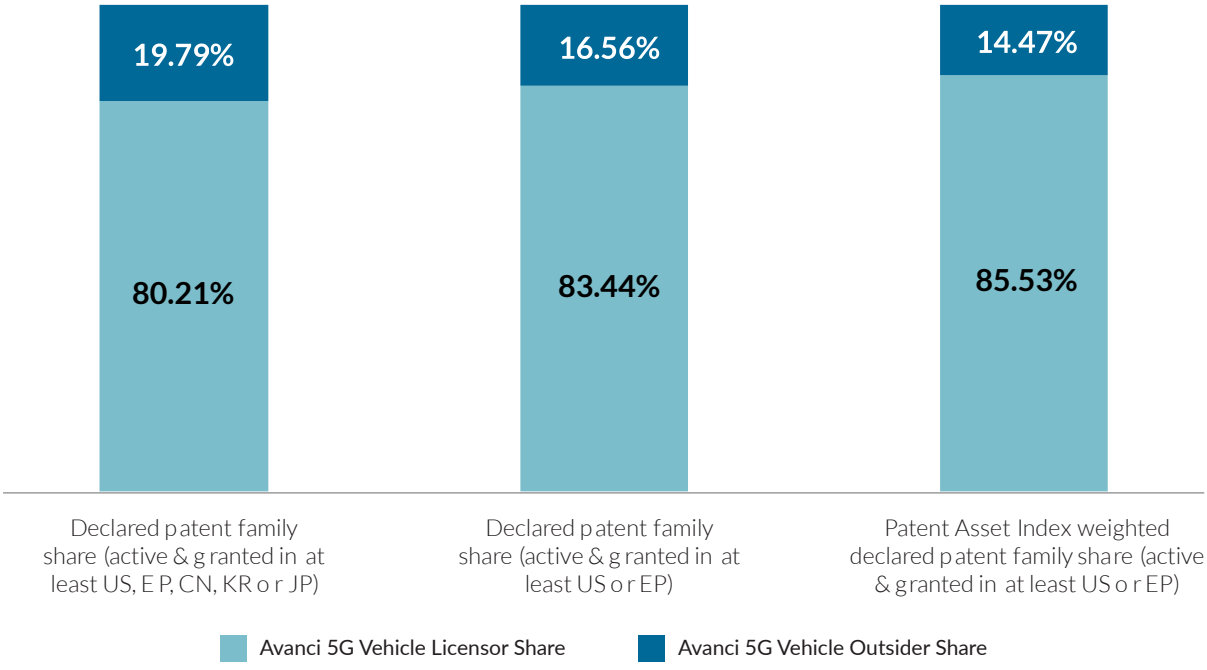


Figure 12: Estimation of Avanci 5G Vehicle Licensors' share by different jurisdictions and weighted by the Patent Asset Index

While the 5G program launch is a step in the right direction, the biggest challenge will be the new royalty rate.[15] It will remain interesting to see how quickly Avanci manages to attract the automotive industry to join before February 16, 2024, when the rate for new licensees increases from $29 to $32 per vehicle.

[15] *https://ipwatchdog.com/2023/08/16/avancis-new-5g-vehicle-program-one-stop-shop/id=165274/*

Smart Factory

The smart factory will be driven by disruptive technologies, such as AI-controlled robots, cloud-monitored machines, real-time sensors, automation technologies connected to the cloud, and augmented reality. These technologies employ connectivity standards to enable communication between all factory components. This enhances data capture and access, speeding up the process significantly. New innovations are poised to become the foundation of production and related services. Automation is expected to handle tasks considered inefficient, unsafe, impossible, or tedious for humans, with remote management for processes requiring human interaction. Thus, connectivity will enable a higher level of accuracy and productivity beyond human capability.

Smart Energy

The energy sector faces various challenges, many of which can be solved with new standards-enabled connected services and applications. As energy networks become smarter, connectivity will support machine-type communications (MTC) to protect, control and regulate networks. Electric mobility drives electricity demand, necessitating a high-capacity, high-bandwidth connected infrastructure for managing smart meters. Further, real-time information on energy consumption at home, work or in traffic will allow users to adjust for efficiency. Finally, intelligent connected systems will enable energy suppliers to balance and manage the demand for energy resources.

Smart Home

In today's world, there is a growing focus on smart home solutions for daily living. Whether in stores or new apartments, individuals are encountering a range of connected devices, such as smart climate control, lighting, beds, TVs, smart kitchen appliances, and home security systems. User interfaces powered by artificial intelligence, including voice, gesture, and biometrics, are expected to drive the growth of smart home technology in the coming years. The range of home automation solutions available is extensive, and there are many relevant connectivity standards to consider, including 5G and others.

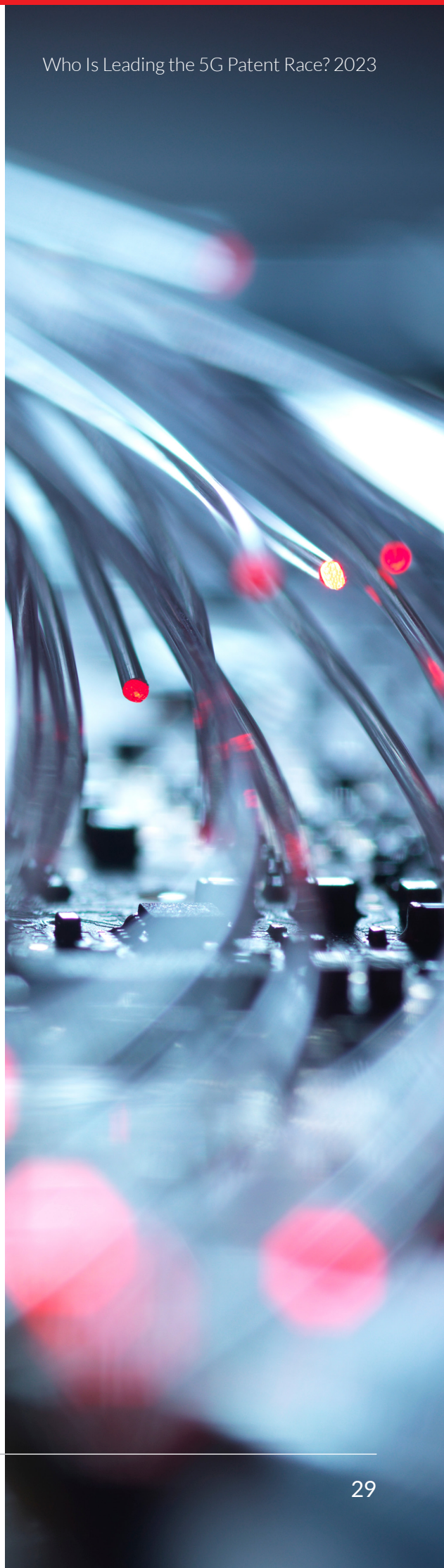
Smart Healthcare

Medical technology is constantly improving, with smart devices offering new and exciting possibilities for patient care. These devices are now able to perform remote examinations and surgeries, thanks to advancements in technology like 5G. This means that healthcare systems can offer intelligent remote monitoring to more patients than ever before, with real-time data providing high-quality care. Medical professionals can now access critical health services and receive instant information about a patient's condition, including HD-quality images, access to medical records, and direct interaction during remote surgery.

5 Important Considerations for the 5G Future

Licensing 5G SEPs is a difficult task, not just for the mobile phone industry, but for any sector that depends on 5G technology. Senior patent directors, licensing executives, or legal counsel should keep in mind that:

- Future technologies that enable connectivity will increasingly rely on technology standards subject to SEPs, such as 5G.
- The number of 5G SEP declarations as well as the number of SEP owners has constantly increased, and fragmented SEP ownership increases the complexity of SEP licensing.
- Implementers of connectivity standards must consider royalty costs and appropriate security payments in advance.
- They ought not only to consider information retrieved from raw patent declaration data but refine such data when used as a reference point.
- SEP determination and value estimation is crucial to make accurate assumptions about 5G leadership and market shares.



Mastering SEP Strategies: Unlocking Value Through Actionable Patent Insights

Patent declaration databases provide crucial insight into SEP ownership, serving as a starting point for stakeholders. To engage effectively in standard development, licensing, and patent pool formation, comprehensive access to declared, pooled, and standards contributions data is essential.

Optimize ROI for SEP portfolios using analytics and strategic decision making. SEP portfolios remain dynamic due to evolving patents and changing standards. Calculating market share requires:

- **Patent declaration data** and the relation to standards generations, versions, releases and time ranges
- **Patent legal status data**, to identify the legal status (lapsed, expired, active, revoked or abandoned) and change of ownership across all jurisdictions;
- **Ultimate Owner data**, to consider worldwide reassignments and integrate corporate tree information to consider M&A activities; and
- **Standards data**, to identify the approval of contributions, freeze of standards releases and publication of new standards versions.
- **Patent quality data**, to identify patent families and entire portfolios that are more relevant and valuable in a given technology field.

To calculate a SEP holder's market share for a particular standard, such as 5G, a market share fraction analysis is conducted. The denominator represents the total number of active and granted SEPs for that standard, while the numerator refers to the patent owner's SEP portfolio. By dividing the numerator by the denominator, the SEP holder's market share can be determined.

To engage effectively in standard development, licensing, and patent pool formation, comprehensive access to declared, pooled, and standards contributions data is essential.

From Data to Deals: How SEP Players Can Drive Innovation and Profitability

SEP Licensors

Utilize the data sources listed previously to align standards development, patent prosecution, patent portfolio management and licensing strategies that maintain valid and essential patents while commercializing SEPs globally.

- Patent portfolio managers can leverage cleaned and deduplicated patent declaration data to identify strength and weaknesses in 5G portfolios and benchmark against competitors, allowing for tracking of market share for standards such as 4G, 5G, Wi-Fi, video codec (HEVC/VVC) and supporting informed decisions on developing SEP portfolios.
- Licensing executives use the data to categorize patent portfolios and weed out weaker patents, focusing resources on higher ranked patents and identifying gold nuggets in a portfolio to license or sell. The data enables users to monitor the market and track ownership changes and litigation trends.

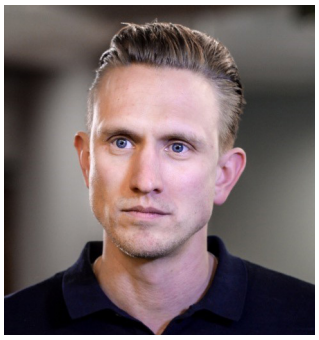
SEP Licensees

Use the data sources listed previously to determine the value of patent portfolios that are offered for licensing, as well as prepare for FRAND negotiation. By identifying the numerator and denominator, it is possible to determine a patent holder's market share and compare SEP licensing offers to other contracts.

Additionally, IP professionals who work for SEP licensees use the data to identify standards that are subject to SEPs within the complex product value chain of suppliers. They also monitor SEP filings, changes in SEP ownership and litigation to quantify risks and plan royalty payments. In a more proactive approach, SEP licensees use this data to identify industry-related standards initiatives or patent pools, such as V2X, NB-IoT, M2M, to ensure a seat at the table when future connectivity technology is developed.

The use of SEPs in the mobile sector is now expanding to other industries, creating opportunities and challenges for both rights holders and implementers. As IP professionals, it is important to consider the future business needs in the next two, five, and 10 years, and what patent portfolio will support them. It is crucial to reevaluate the development, evaluation, and analysis of patent portfolios and competition in all industries. Access to accurate and curated data on patent declarations, pools, and standards contributions is necessary to understand patent landscapes and value 5G portfolios when licensing, joining pools, or acquiring and selling SEPs. It is essential to be proactive instead of reactive and avoid falling behind.

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Tim Pohlmann is the CEO and founder of LexisNexis® IPlytics. He earned his doctoral degree with the highest distinction from the Berlin Institute of Technology, with a dissertation on patenting and coordination in standardization. He then went on to work as a post-doctoral researcher and consultant for the Law and Economics of Patents Group at CERNA, MINES ParisTech. In 2014 he founded IPlytics with the vision to overcome friction and complexity in data-led decisions in industries where standards and patents matter by being the transparent, accessible source of wisdom for all IP professionals.

Tim has been actively involved in preparing empirical studies for the European Commission, the World Intellectual Property Organization and the German federal government on declared patents, standards contributions, patent transfers and patent pooling. He is a recognized thought leader, panel speaker and adjunct lecturer on the topics of Standard Essential Patents (SEPs), FRAND licensing, patent pools and advanced patent intelligence. He was again recognized in the IAM Strategy 300 Global Leaders list 2023 and is author of several peer-reviewed economist journal articles, several Managing IP articles, IPWatchdog articles, IAM Magazine articles, and some of the most-read IAM Media industry reports.

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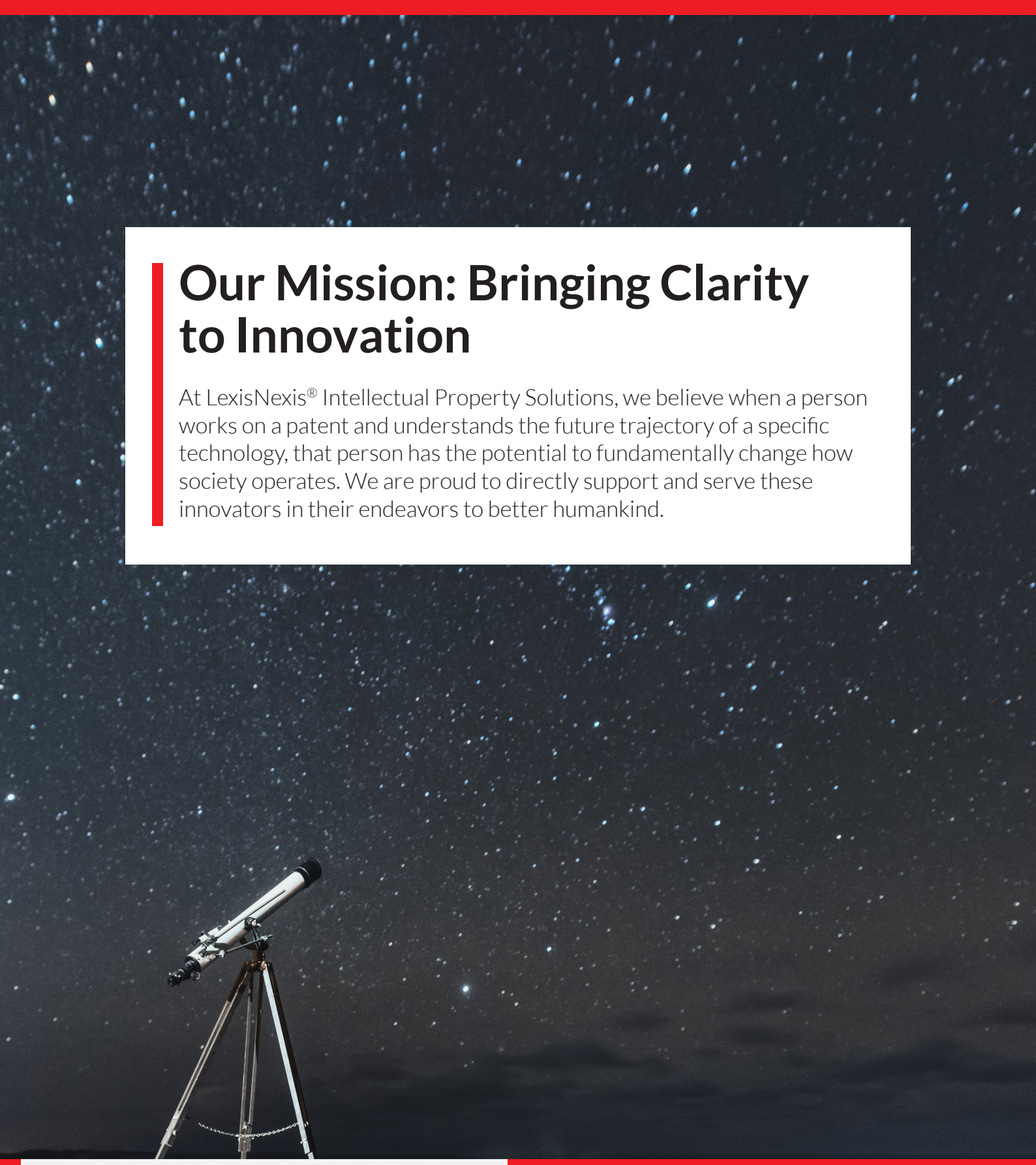
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