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5G Standard Essential Patents Transparency

Promoting efficient and fair 5G implementation, licensing, and royalty determination - Q2 2025

Lite version

Bringing Ingenuity to Life.

Contents

Introduction

This lite version of PA's recent (Q2 2025) 5G Standard Essential Patents (SEP) report presents selected, redacted extracts from our independent, industry-leading expert analysis, often relied upon by 5G SEP stakeholders in high-stake licensing negotiations and litigation contexts.

It offers cleaned and structured 5G SEP declaration data, visibility on actual portfolio essentiality rate ranges, insights into the technology distribution of declarations, and a high-level overview of market dynamics shaping the 5G SEP landscape.

Our aim is to support all 5G SEP stakeholders – whether in licensing, litigation, or policymaking – by providing meaningful, evidence-based insights that promote efficient and fair 5G implementation, licensing, and royalty determination.

The full 5G SEP report offers a comprehensive, evidence-based analysis of actual essential patents held by each patent owner, along with estimated essentiality rates for each portfolio of 5G patent declarations. It also includes access to our continuously updated database of thousands of patent reviews with detailed mappings to the 37 key 5G technology features, such as NB-IoT and network slicing, aligned with the 5G standard specifications.

The full report provides a transparent view of the current ownership of actual essential 5G patents and the full details of their essentiality. With this, we at PA continue to play a critical role in enabling efficient, evidence-based 5G SEP licencing negotiations around the world – whether in the courtroom or in the boardroom.

Request full 5G report

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Executive summary

As 5G matures into a commoditised cornerstone technology, spanning a diverse range of use cases and price points, the 5G market is becoming ever more sensitive to cost and availability. A critical component in this ecosystem is the management and licensing of 5G Standard Essential Patents (SEPs), without which it is impossible to implement standardised 5G technologies.

The current 5G SEP landscape is marked by explosive growth in 5G patent declarations to the European Telecommunications Standards Institute (ETSI), rising from approximately 18,500 in 2019 to nearly 137,500 declared patent families by April 2025 (based on PA analysis). However, a significant challenge persists: **not all declared patents are truly essential.**

Our independent, off-the-shelf report addresses this challenge by offering objective, evidence-based, and comprehensive essentiality analysis of such declared 5G patents.

In this lite version of the report, we highlight that:

- There is a massive disconnect between the number of declared patents and the number of truly essential ones; more declarations do not necessarily equate to more essential patents
- Essentiality rates for the top 25 5G patent owning companies vary widely between the 10th and 90th percentiles, underscoring a lack of correlation between portfolio size and actual technology leadership
- The overall essentiality rate for any generation of wireless technology has yet to exceed 50 percent, even as the number of declared patents to such standards has grown exponentially from 3G to 5G
- More than 70 percent of reviewed patents deemed potentially essential to 5G are related to the physical layer and the radio access network (RAN) technologies
- The 5G patent landscape is increasingly dynamic, with substantial patent transactions, mergers, and acquisitions resulting in a fluid ownership base.

In light of this, we present **a suite of key activities** for parties on both sides of the negotiation table to facilitate effective deal making – helping technology originators, users, and integrators to reduce transaction costs and other inefficiencies:

For SEP licensees:

Readiness: Acquire SEP transparency reports and build robust IP strategies, including supplier indemnification clearance.

Standards engagement: Actively participate in standard-setting bodies (e.g., ETSI, ANSI, ITU) to influence the process.

Industry collaboration: Drive thought leadership, analyse legal precedents on fair, reasonable, and non-discriminatory (FRAND) terms, and engage in collective efforts to align industry interests.

For SEP licensors:

Data integrity: Clearly define the population of SEP families, conduct rigorous essentiality checks, and ensure data consistency across negotiations and legal contexts.

Expert involvement: Involve technical experts early in the negotiation to support licensing discussions and court proceedings.

Market alignment: Stay active in Standards Developing Organisations (SDOs), benchmark licensing practices, and leverage patent pools to optimise transaction efficiency and coverage.

By bringing greater transparency to SEP essentiality, our expert-led analysis aids SEP owners, licensees, negotiators, courts, and other stakeholders in making more informed and efficient business, legal, and regulatory decisions.

Navigating the complex 5G SEP landscape

5G technology is being adopted at scale across markets, including in the consumer, manufacturing, healthcare, telecoms, and transportation sectors. Similar trends have been observed in the 5G SEPs domain, where declarations to the European Telecommunications Standards Institute (ETSI) have increased exponentially in recent years.

Many companies own patents they claim are 'essential' to wireless telecom standards. However, not all patents are truly essential. There's a great deal of uncertainty about which of the declaring companies own essential patents, and which of them have the dominant share. This ultimately gives rise to more challenges in 5G SEP licensing.

While holders of SEPs must be prepared to grant licences under fair, reasonable, and non-discriminatory (FRAND) terms and conditions, patent declarations to ETSI generally provide little information about the current ownership status of such patent portfolios, including the actual scope, quality, and/or value.

Fair cost and universal availability can best be balanced against the investment needed for technology advancement. But this requires transparency of the true number of SEPs relevant to the deployment of 5G technologies owned by each company.

The issue of transparency is an ongoing challenge and governments have tried to address this through legislation. For example, the EU developed a proposal for regulation (COM(2023)232 – APR 2023) to establish a framework protection for transparent licensing of SEPs. This effort was recently abandoned due to "no foreseeable agreement" between various stakeholders – highlighting both the complexities of this space and stakeholders' appetite to reach consensus through market-led approaches in place of such regulatory intervention. However, there are new attempts at resurrecting the SEP regulation proposal – or a variation thereof.

To address the issue of transparency, we have produced independent reports that offer SEP transparency through objective, evidence-based analysis of the true essentiality of patents pertaining to 5G technology and other telecommunications technology domains. Our reports are used by industry leaders, IP negotiators, arbitrators, or litigators, as well as courts in various jurisdictions such as the UK and the US to facilitate more efficient and expert-led negotiations, arbitrations, mediations, and for enforcement activities.

Through internal investments alone, our in-house engineers and telecommunication experts reviewed and determined which of the declared patents are essential to 5G. In doing so, our essentiality analysis is the only independent solution on the market that provides a transparent framework for reaching fair licensing agreements among technology originators, users, and integrators.

The number of patent declarations is a poor measure of the number of essential patents or quality of the patent portfolio

We found that the essentiality rate of a company's patent portfolio is not dependent on the number of declared patents owned by that company. In some instances, portfolios with many declared patents have a lower number of actually essential patents than those of smaller size. Therefore, the number of declarations in itself is a poor proxy for technology leadership within a particular standard category.

Findings – driving your 5G strategy

Our unique source of essentiality data guides technology originators, users, and integrators through the ever-expanding 5G patent landscape, helping them to unlock effective, evidence-based business decisions.

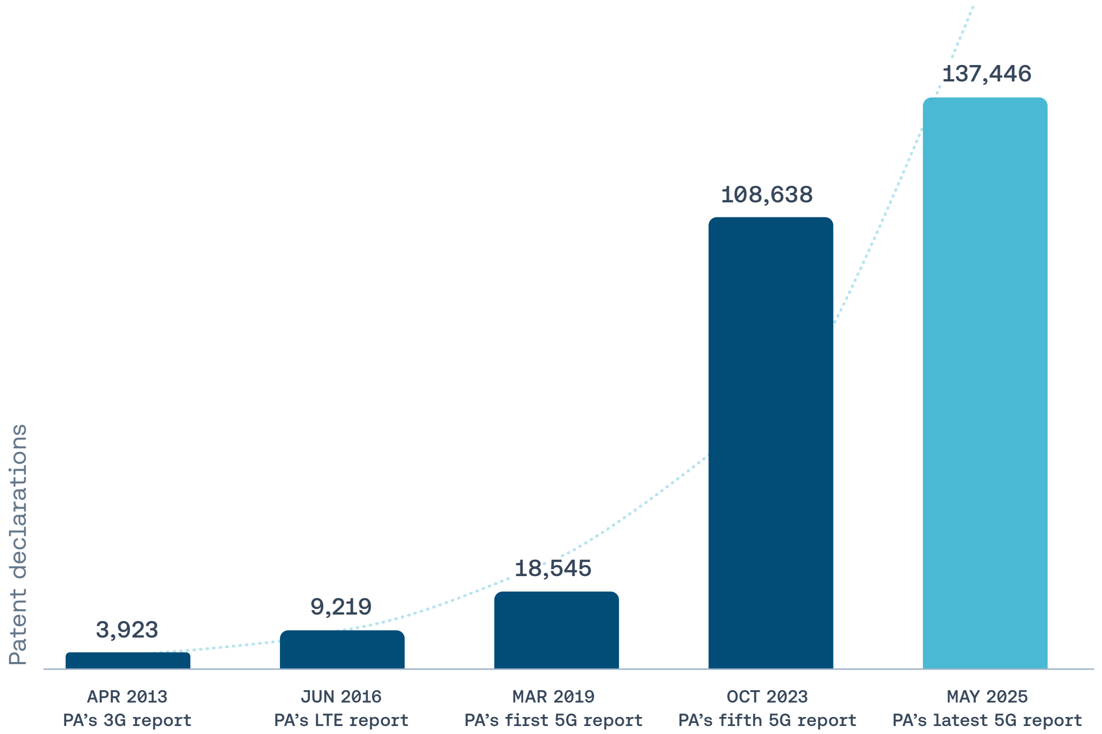
Our full 5G SEP report, which covers all patent declarations made to ETSI up to 22 April 2025, identifies the following emerging trends:

- More than 70 percent of all patents deemed potentially technically essential to 5G are related to the physical layer and radio access network (RAN) technologies
- There has been a clear trend towards an increase in essentiality rates of all patents over the past decade as the market has migrated from 3G to 4G, and finally to 5G technology, without the overall essentiality rate actually reaching 50 percent
- The essentiality rate for the top 25 companies, based on current ownership of patents, varies significantly between the 10th and 90th percentiles.

An exponential increase in patents declared to telecom standards

We identified 137,446 patent declarations that were made to ETSI up to 22 April 2025, clearly evidencing that there has been a significant increase in the submission of patent declarations thought to be related to 5G technologies. The number of declared patent families has increased nearly eight times since November 2019, which makes the overall trend in the declaration of patents to 3G, 4G, and 5G related technologies one of exponential growth.

Figure 1: Exponential growth in the number of patent declarations to ETSI since 2013



Out of the 137,446 unique patent declarations, we identified 62,276 ETSI families with at least one granted patent in the world's six largest patent jurisdictions: US/EP/CN/KR/JP/IN. Our analysis of original declarants, based on this data, indicates that US, China, and European jurisdictions have the highest priority for technology originators in terms of filing for patents and the subsequent prosecution to grant these, with Japan, Korea, India, and Brazil respectively as the jurisdictions with the next highest priority.

Figure 2: Number of patent families with at least one grant in each of the key jurisdictions

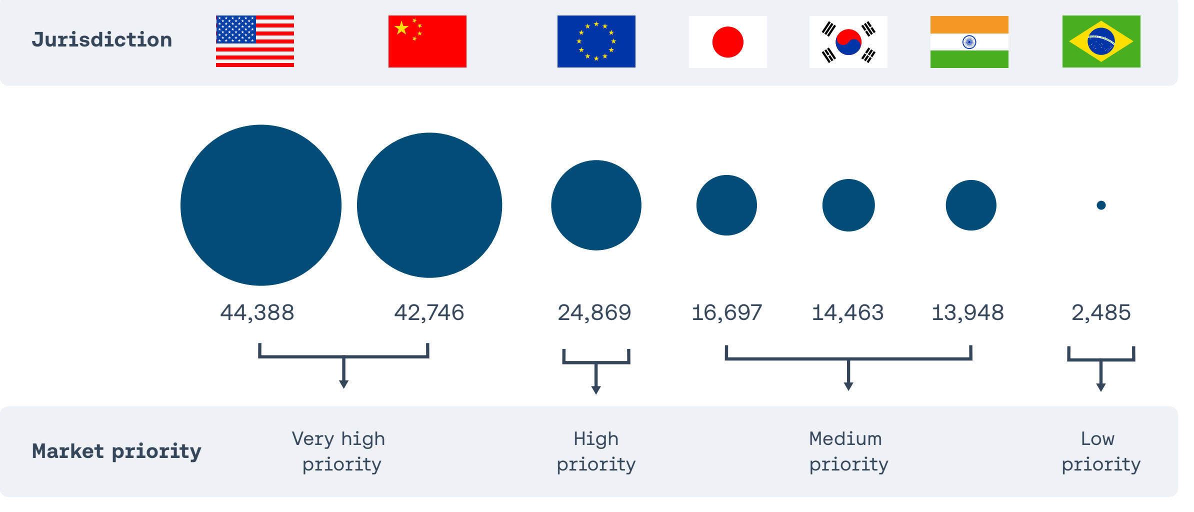


Figure 3: Overall ownership share of declared granted families by declaring company

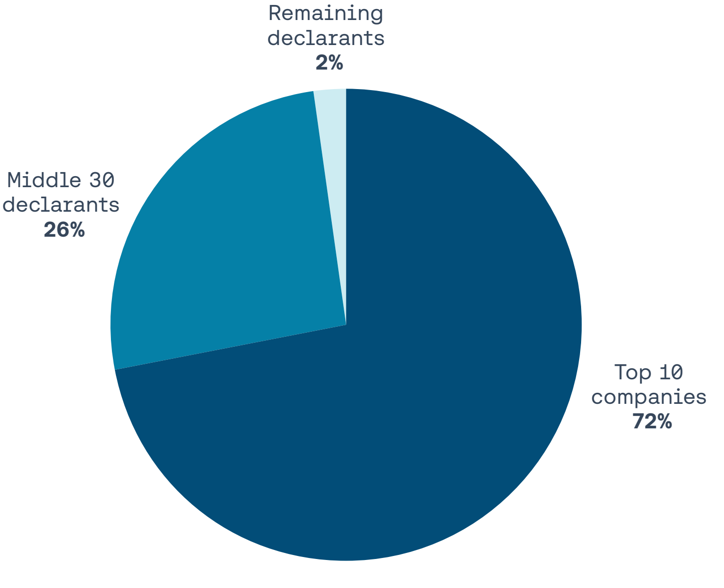


Figure 4 on page 17 shows a plot of the top 40 companies based on total granted and non-granted declarations to ETSI is provided below. Uncertainty in the number of applications that will eventually be granted means the actual number of granted patents can be significantly lower than indicated declarations. **In addition, a table containing the number of granted patent families currently owned and previously declared by each company is provided in the Appendix**.

The table shows:

- Huawei, Qualcomm, and Samsung now take the dominant positions for currently owned patent families with at least one granted patent in major jurisdictions (US/EP/CN/KR/JP/IN), followed by LG, ZTE, Ericsson, and Nokia.
- Huawei and Qualcomm continue to hold the top positions for all patent families declared to ETSI (including those with patent publications and pending applications in all jurisdictions), with NTT Docomo slipping down the table below CATT/Datang, and Vivo.

As per declarations to previous technologies, the average scope, quality, and value of each company's declared patent portfolios vary significantly.

This means that the actual company ranking in terms of truly essential patents differs significantly from the ranking below in terms of total declarations.

Figure 4: Top 40 declaring companies and the breakdown of granted and non-granted patent families

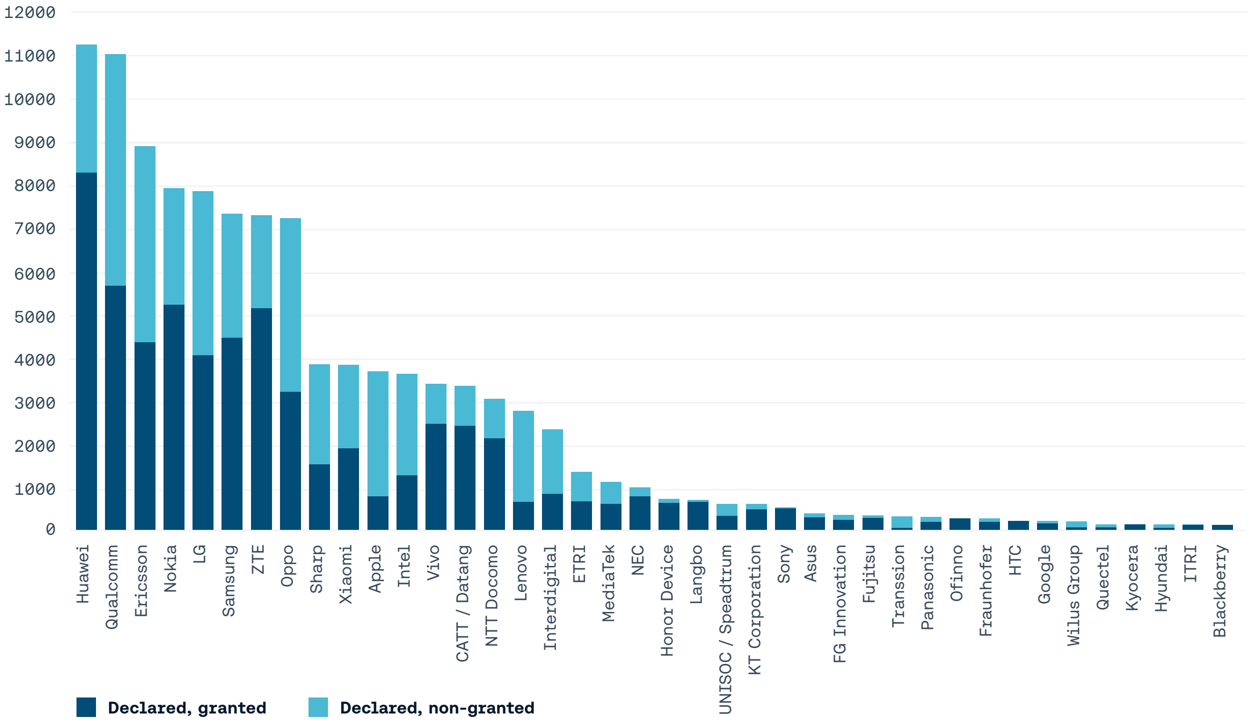
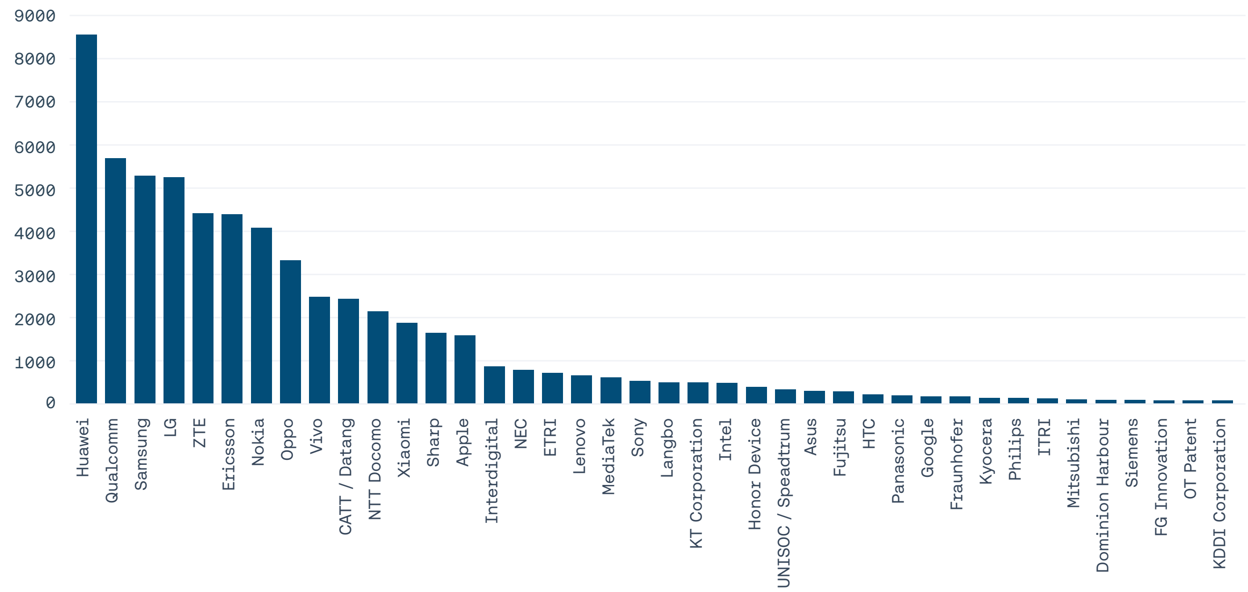


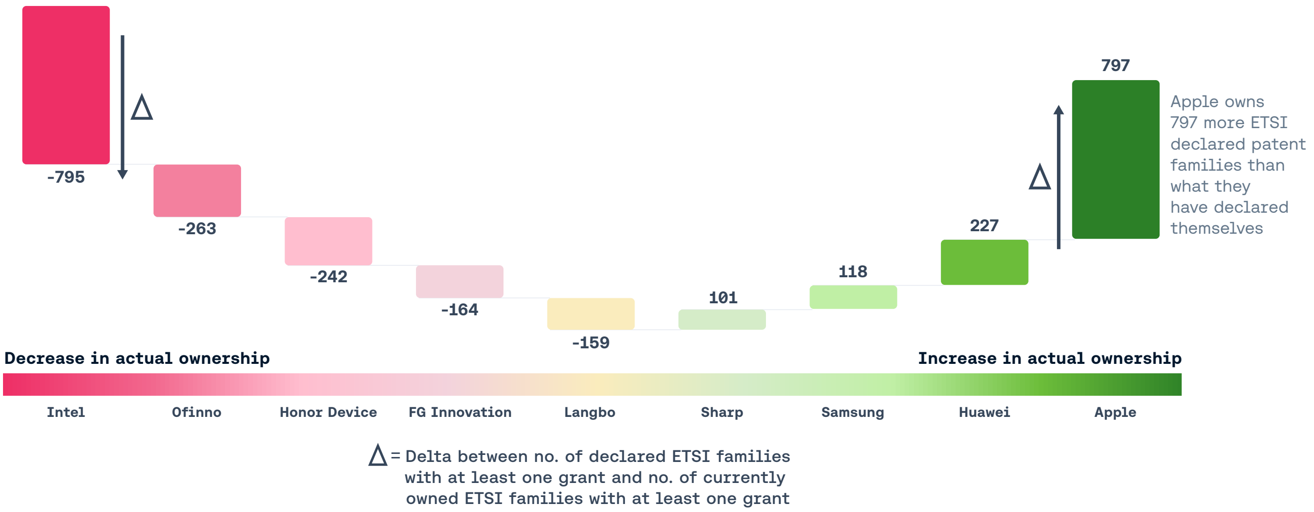
Figure 5: Top 40 companies based on the current ownership of declared patent families



The 5G patent landscape is significantly evolving

There are 145 companies that either currently own granted patents declared to ETSI, or have declared patents to ETSI in the past, pertaining to 5G technologies. Out of the 145 companies, 64 percent are original declarants of patents to ETSI and the remaining 36 percent comprise non-declarants, i.e. those who may have acquired patents through other means. The non-declarant cohort consists of a wide range of companies, including technology and product companies and Non-Practicing Entities (NPEs), indicating a degree of fluidity in the patent market relating to 5G technologies, and high willingness to sell to NPEs.

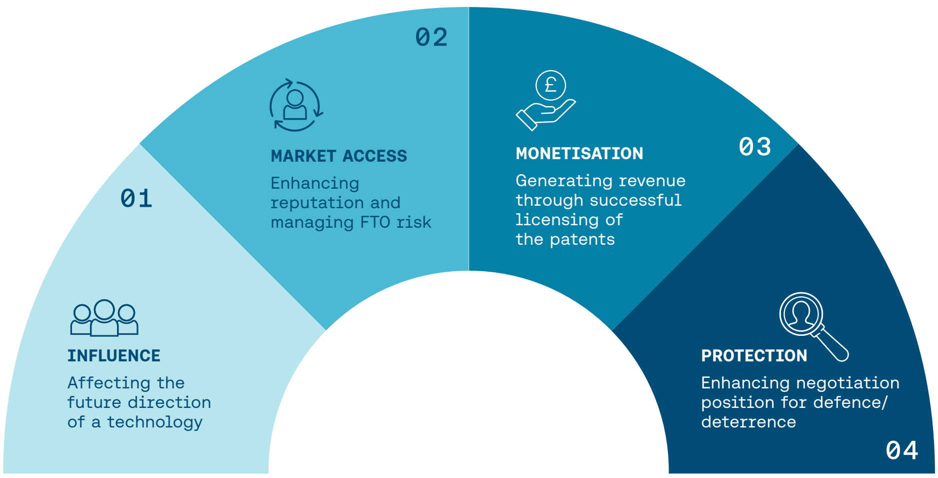
Figure 6: The decrease/increase in the number patent families for a sampled list of nine companies



Several factors drive changes in 5G patent ownership including acquisitions, divestitures, and the re-assignment of rights to or from subsidiaries. Companies often employ these strategies to influence the future direction of 5G technologies and related standards, or to enhance their negotiating positions with competitors.

For instance, our analysis reveals that Intel now holds 795 fewer declared patent families than initially reported – evidence of a strategic shift away from 5G investments. All of these patents were acquired by Apple, reflecting their efforts to strengthen their 5G portfolio.

Figure 7: Contributing parameters to the fluidity of the 5G patent market



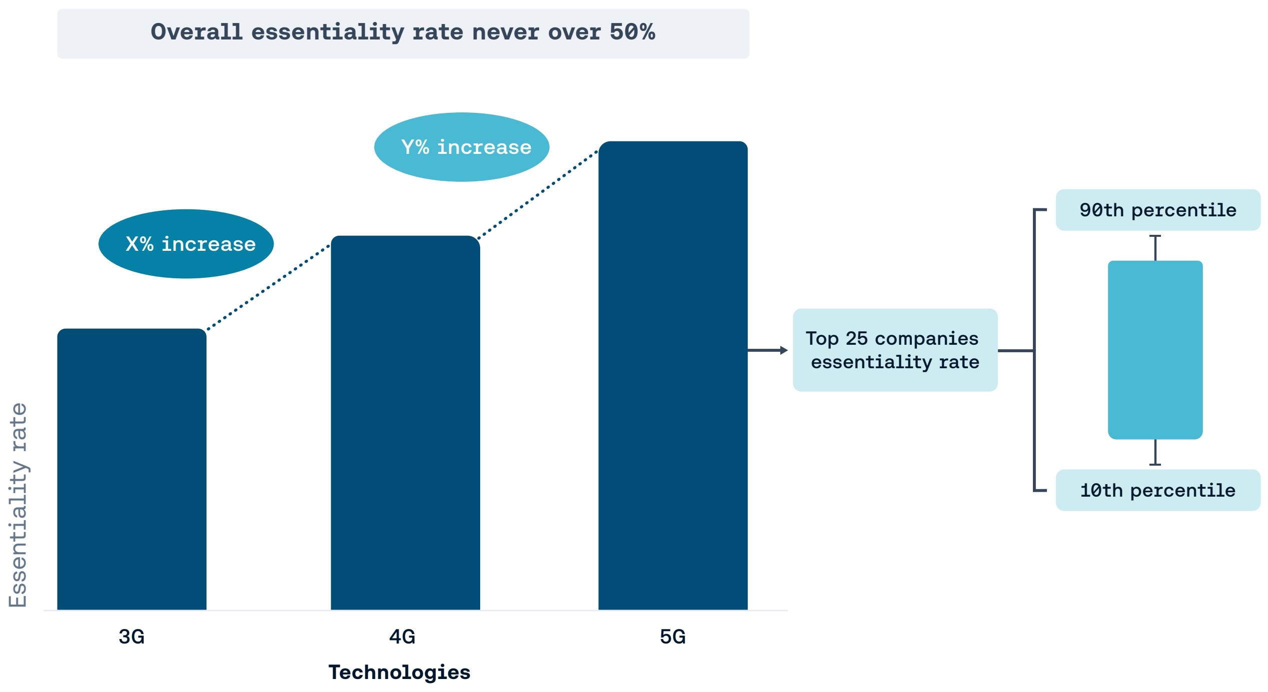
More declarations do not always translate into more essential patents

Our study identifies a notable upswing in the total number of essential patents in the 5G space, resulting from a significant increase in the submission of patent declarations thought to be related to 5G technologies by declaring companies. However, there is considerable variation in the relative 'current' holding of essential patents across companies, which significantly alters the declaration rankings mentioned in Figure 4.

The essentiality rate for the top 25 companies, based on current ownership of patents, varies significantly between 10th and 90th percentiles. This results in uncertainty for both SEP licensors and licensees of 5G SEPs unless they have access to the true essentiality results.

The overall patent portfolio essentiality rate for each Third Generation Partnership Project (3GPP) technology has increased for each subsequent technology since early 3G. While on the rise, the essentiality rate for any technology has never been greater than 50 percent of the corresponding declarations, indicating a strong need for transparency with essentiality of patents.

Figure 8: Essentiality rates since 3G and variation in 5G essentiality rates



The over-declaration of patents to standards can be understood in the context of standard setting organisations' IPR policies, the dynamic nature of the standard-setting process, and patent prosecution uncertainties among other factors.

One outcome of these factors is that companies have to declare inventions when both the patent and the technology being standardised are at drafting stage and subject to change in the future, which may lead to a large number of declared but ultimately non-essential patents.

Key factors affecting the patent declaration approach adopted by companies to standards

Standard Setting Organisations' IPR policies	ETSI IPR policies require companies to declare patents which are thought to be essential or might be essential to the 5G standard, which can lead to over-declaration of patents.
Standard setting process	This is a dynamic process. At the time of disclosure of the patent it is unclear whether the patented invention will be implemented as part of the standard or what direction the standardisations may take.
Patent prosecution process	There are uncertainties associated with this process that can take several years. For instance, the patent may not be granted at the end of this process, the direction of the standard may change, and the patented solution may no longer be implemented, or the scope of the invention may be narrowed and modified through the prosecution process.
Expansion of 5G and its interaction with other fields	The expansion in the use of 5G in other fields, and the use of other technologies in 5G has led to the development of inventions where the inventive step includes 5G related elements in addition to other elements. This has led to an increase in patents which must be assessed for essentiality by all stakeholders in the 5G space

These developments have resulted in unprecedented numbers of patent declarations to standards and consequently, to an urgent need for solutions providing greater transparency for SEP stakeholders. Our independent essentiality reports is one of few instruments that equip technology originators, users, and integrators to effectively navigate questions regarding transparency in the 5G patent space, providing clarity during 5G implementation decisions and royalty determination negotiations.

Shaping the SEP agenda

We believe that to effectively navigate this increasingly complex 5G SEP landscape, and maximise related commercial benefits of 5G technologies, 5G originators, users, and integrators should consider how they could influence and shape their industry 5G SEP agenda to facilitate the right conditions for effective deal making and negotiation to reduce transaction costs and other inefficiencies.

Figure 9: Key activities that technology originators, users, and integrators should consider when navigating the 5G patent landscape

SEP licensees | **SEP licensors**

Equip yourself with the right tools

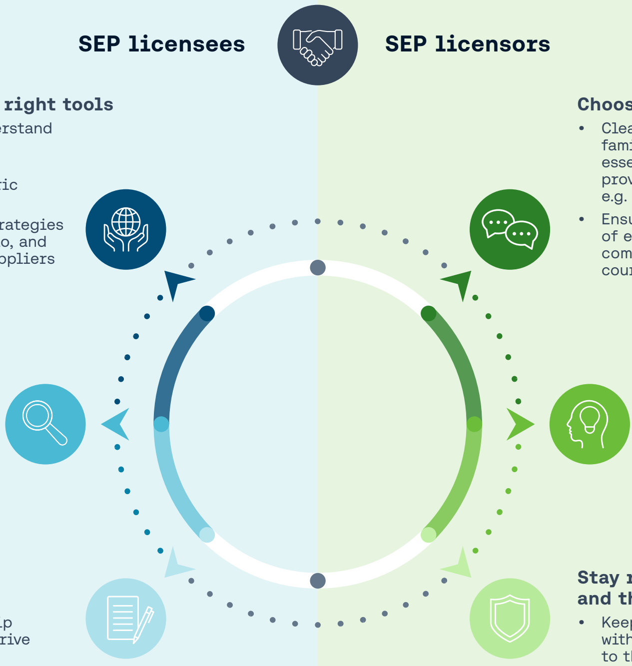
- Acquire SEP data and understand the SEOP licensing world
- Get transparency reports to equip against asymmetric licensor negogiations
- Develop appropriate IP strategies e.g. strong patent portfolio, and IP idemnification from suppliers

Engage with standard bodies

- Understand their operations e.g. ETSI, ARIB, ITU
- Participate in the standardisation process e.g. 3GPP

Engage with industry stakeholders

- Produce thought leadership and industry insights to drive engagement with peers
- Analyse recent court decisions and form views on the latest judicial FRAND decisions
- Take collective actions through talking to peers and forming a common position



Choose your data wisely

- Clearly define and list the patent families that are declared to be essential to the 5G standard and provide evidence of essentiality e.g. third party data, claims charts
- Ensure consistent application of essentiality data throughout commercial negogiations and courts proceedings

Engage experts from the outset

- Involve the relevant experts to back up the essentiality data in negotiations and courts proceedings
- Engage in technical meetings on patent mapping and use in the standard

Stay relevant with SDOs and the market

- Keep essentiality declarations with SDOs current and accurate to the best of your knowledge
- Benchmark royalty rates and licensing models within the industry
- Be prepared to provide further evidence regarding patent technical coverage and its importance

Our full report further provides a transparent view of the 5G SEP landscape, aimed at all 5G SEP stakeholders.

Methodology

Our expert-led evaluation methodology is based on a deep understanding of wireless specifications gained from practical experience, such as developing products handsets and infrastructure equipment for our clients.

Manual reviews based on robust sampling methodology

We use the ETSI definition of an essential patent to identify such patents, which broadly means that a patent is essential if it is technically impossible to build a solution that complies with the standard without infringing on the patent.

Given the large number of patent families declared as potentially essential to 5G ETSI Technical Specifications, an exhaustive, manual analysis of all declared patent families was not practical. Artificial Intelligence (AI) is a valuable tool for cleansing 5G patent data, as well as for high-level assessment of patent relevance. However, due to legal expectations for utmost transparency and accuracy, and the necessity for rigorous human verification of such data in high-stakes legal contexts, AI without human intervention cannot yet be relied upon for the essentiality review and analysis of 5G patent declarations.

As a result, we followed a stratified sample-based approach for the essentiality patent ranking. Our engineers and experts conducted manual technical reviews on the sampled patents to get an accurate assessment of the percentage of essential patents. This differentiated approach, together with a robust sampling methodology and our stakeholder independence provides a more accurate picture of the overall 5G SEP landscape and individual company's actual 5G SEP share.

Our approach to essentiality analysis

Step 1

We identified the patents declared to ETSI for all 5G relevant specifications and projects. We split the declaring companies into groups based on the number of declared ETSI patent families with at least one granted patent in the jurisdiction of US/EP/CN/KR/JP/IN. We then sampled patents individually for the top 40 companies, and combined for the remaining companies, to achieve a statistically robust sample per patent holder.

Step 2

We carried out the essentiality analysis, scoring each patent and providing a reasoning for the score. The team assessed the independent claims of each patent, ranking each assessed patent from one to four:

1. Potentially essential to the technical standards
2. Relevant to the technical standards but not directly mandated by it
3. Not relevant to the technical standard and
4. Not relevant by domain.

Step 3

We conducted further peer reviews to ensure consistency of scoring principles and the accuracy of claims mapping.

Step 4

To add further richness to our essentiality analysis, we also provided:

- our rationale for the patent ranking along with references to the mapped section of the technical specifications
- categorised patents based on 5G features (e.g. network slicing, MIMO, etc.) to which the claim reads onto
- technology mapping of the actually essential patents to the relevant infrastructure component, namely User Equipment (UE), NodeB, and core network
- the current ownership status of declared patents and consequently the ‘current’ essentiality rate for the patent portfolio of each company, taking into account factors such as patent transactions, Mergers and Acquisitions (M&A), and spin-offs.

Appendix

Table 1: Declaring companies and the breakdown of granted and non-granted patent families

Numeri ID	Company	Currently owned declared families with a grant in US / EP / CN / KR / JP / IN	Declared families with a grant in US / EP / CN / KR / JP / IN
1	Huawei	8519	8292
2	Qualcomm	5661	5667
3	Samsung	5260	5142
4	LG	5224	5227
5	ZTE	4391	4458
6	Ericsson	4372	4350
7	Nokia	4058	4054
8	Oppo	3304	3204
9	Vivo	2463	2454
10	CATT / Datang	2412	2406
11	NTT Docomo	2122	2123
12	Xiaomi	1853	1891
13	Sharp	1622	1521
14	Apple	1573	776
15	Interdigital	847	833
16	NEC	769	776
17	ETRI	703	660
18	Lenovo	645	645
19	MediaTek	599	599
20	Sony	518	498
21	Langbo	483	642
22	KT Corporation	477	473
23	Intel	471	1266

Numeri ID	Company	Currently owned declared families with a grant in US / EP / CN / KR / JP / IN	Declared families with a grant in US / EP / CN / KR / JP / IN
24	Honor Device	381	623
25	UNISOC / Spreadtrum	314	314
26	Asus	287	287
27	Fujitsu	270	270
28	HTC	202	203
29	Panasonic	180	180
30	Google	153	151
31	Fraunhofer	151	177
32	Kyocera	124	125
33	Philips	121	59
34	ITRI	114	114
35	Mitsubishi	90	90
36	Dominion Harbor	78	0
37	Siemens	78	72
38	FG Innovation	59	223
39	OT Patent	59	0
40	KDDI Corporation	58	58
41	KAIST	54	0
42	Coolpad	52	49
43	IP Bridge	50	0
44	Blackberry	48	107
45	Quectel	48	48
46	Wilus Group	44	53
47	Orange	42	42
48	TCL Communication	42	0
49	Sun Patent Trust	41	43
50	Innovative Technology Lab	40	46
51	Deutsche Telekom	37	36
52	Convida	36	80
53	KPN	36	36
54	Ueran	36	0
55	Denso	34	30

Numeri ID	Company	Currently owned declared families with a grant in US / EP / CN / KR / JP / IN	Declared families with a grant in US / EP / CN / KR / JP / IN
56	Hyundai	33	39
57	Transsion	33	43
58	Longhorn IP	32	0
59	Innovative Sonic	31	32
60	Meizu	30	29
61	IPCom	19	19
62	Toyota	19	16
63	Institute For Information Industry	18	18
64	Semtech / Sierra Wireless	18	0
65	Optis Wireless	16	24
66	Acer	15	15
67	Cloudminds	14	14
68	G+ Communications	14	0
69	Voiceage	14	16
70	Broadcom	13	0
71	Cisco	13	7
72	SK Telecom	13	11
73	Vodafone	13	13
74	Comba	12	12
75	Telit Cinterion	11	0
76	Unwired Planet International	10	3
77	Verizon	10	10
78	Wistron Corporation	10	10
79	Gionee	9	0
80	HMD Global	8	8
81	MiiCs & Partners	7	0
82	Sisvel	7	1
83	Tahoe Research	7	0
84	5g Ip Holdings	6	0
85	Crystal Clear Codec	6	0
86	Kia Corporation	6	0

Numeri ID	Company	Currently owned declared families with a grant in US / EP / CN / KR / JP / IN	Declared families with a grant in US / EP / CN / KR / JP / IN
87	Thales	6	19
88	Apex Beam Technologies	5	0
89	Eight Deer Ventures	5	0
90	Hedwig Wireless	5	0
91	Jingshi IP	5	0
92	Malikie Innovations	5	0
93	Ruijie	5	6
94	JVC Kenwood	4	0
95	National Instruments	4	4
96	Nera Innovations	4	0
97	Amazon	3	0
98	Munitech	3	0
99	Rakuten	3	3
100	Shanghai Qiyu	3	0
101	Wireless Future Technologies	3	0
102	3G Licensing	2	0
103	AT&T	2	0
104	Cluster	2	0
105	Conversant	2	1
106	Intellectual Discovery Co	2	0
107	Telecom Italia	2	2
108	TriSpace	2	2
109	Wsou Investments LLC	2	0
110	Zhigu	2	0
111	3vjia	1	0
112	Aisin	1	0
113	Anirudh Singh	1	1
114	Cambridge Positioning Systems	1	0
115	Canon	1	0
116	China Mobile	1	0
117	Coranci LLC	1	0
118	Daingean Technologies	1	0

Numeri ID	Company	Currently owned declared families with a grant in US / EP / CN / KR / JP / IN	Declared families with a grant in US / EP / CN / KR / JP / IN
119	Dell	1	1
120	DiDi	1	0
121	FuRyu	1	0
122	Han Hee	1	0
123	Kingsoft	1	0
124	Lite-On	1	1
125	Methode Electronics	1	0
126	Polaran	1	1
127	RPX Corp	1	0
128	Rfinity	1	0
129	SiBeam	1	0
130	Stingray IP	1	0
131	Teleste Oyj	1	1
132	University of Sherbrooke	1	0
133	Visa	1	0
134	BBK Electronics	0	80
135	General Dynamics	0	1
136	Godo Kaisha IP Bridge 1	0	10
137	Hubei	0	1
138	JRD Communication	0	1
139	Ofinno	0	263
140	Semtech	0	1
141	Shenzhen TCL	0	1
142	Sierra Wireless	0	17
143	TCT Mobile	0	41
144	Telit	0	2
145	Ukpik	0	3

About PA

We believe in the power of ingenuity to build a positive human future.

As strategies, technologies and innovation collide we create opportunity from complexity.

Our diverse teams of experts combine innovative thinking and breakthrough technologies to progress further, faster. Our clients adapt and transform, and together we achieve enduring results.

We are about 4,000 strategists, innovators, designers, consultants, digital experts, scientists, engineers and technologists. And we have deep expertise in consumer and manufacturing, defence and security, energy and utilities, financial services, government and public services, health and life sciences, and transport.

Our teams operate globally from offices across the UK, Ireland, US, Nordics and Netherlands.

Discover more at paconsulting.com and connect with PA on LinkedIn and X.

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