

Who is leading the 5G patent race?

A patent landscape analysis on declared SEPs and standards contributions

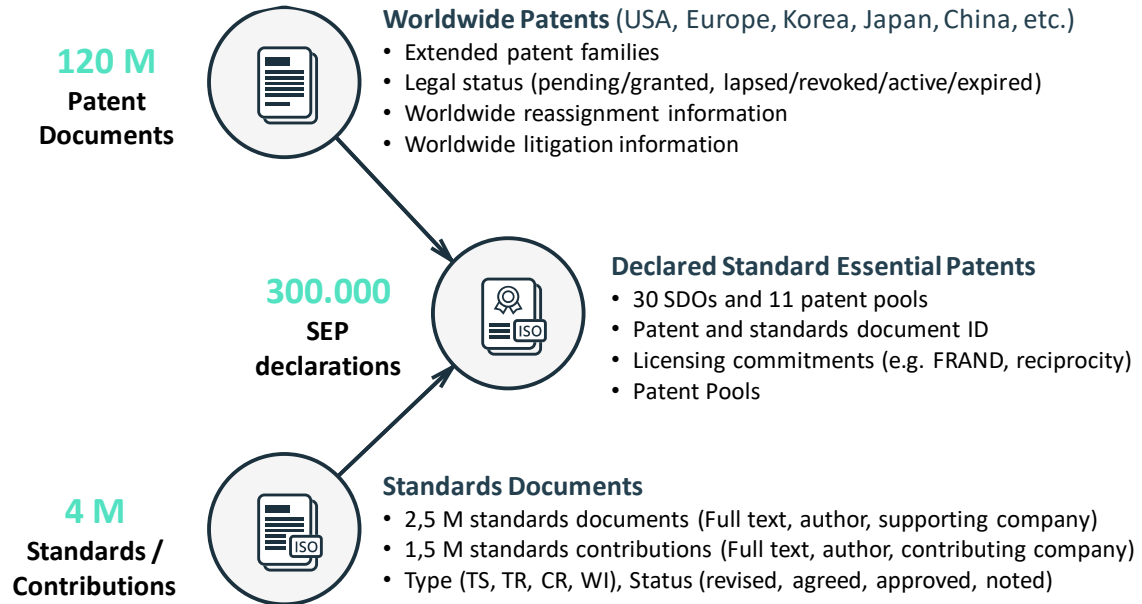
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1. Introduction and data sources

The long-term vision is that 5G will empower the invention of thousands of new products, technologies and services, increase productivity and allow for new industries to emerge. A global 5G network will unify mobile communication in order to connect individuals and devices to everything through the Internet of Things (IoT), with 5G technologies linking vehicles, ships, buildings, meters, machines and other items with electronics, software, sensors and access to the Cloud. The past few years have shown that 3G and 4G patent holders have controlled how mobile technologies are used in the smartphone industry. Owners of 5G SEPs will likely become technology and market leaders, thus enabling 5G connectivity in various markets. Further, companies will have to use SEPs when implementing standardized 5G technology.

The IPlytics Platform integrates data from worldwide patents, SEP declarations, standards and contribution documents. The database shows patents that have been declared essential for the 5G standard. Figure 1 illustrates how patent documents, declared SEPs, standards and contribution documents are integrated to allow a thorough analysis in all three connected databases. This approach allows the platform to precisely define whether a SEP declaration is 5G, 4G, or 3G relevant, or relevant for combinations of multiple standards generations. The following analysis is based on standards specifications that exclusively relate to 5G specifications.

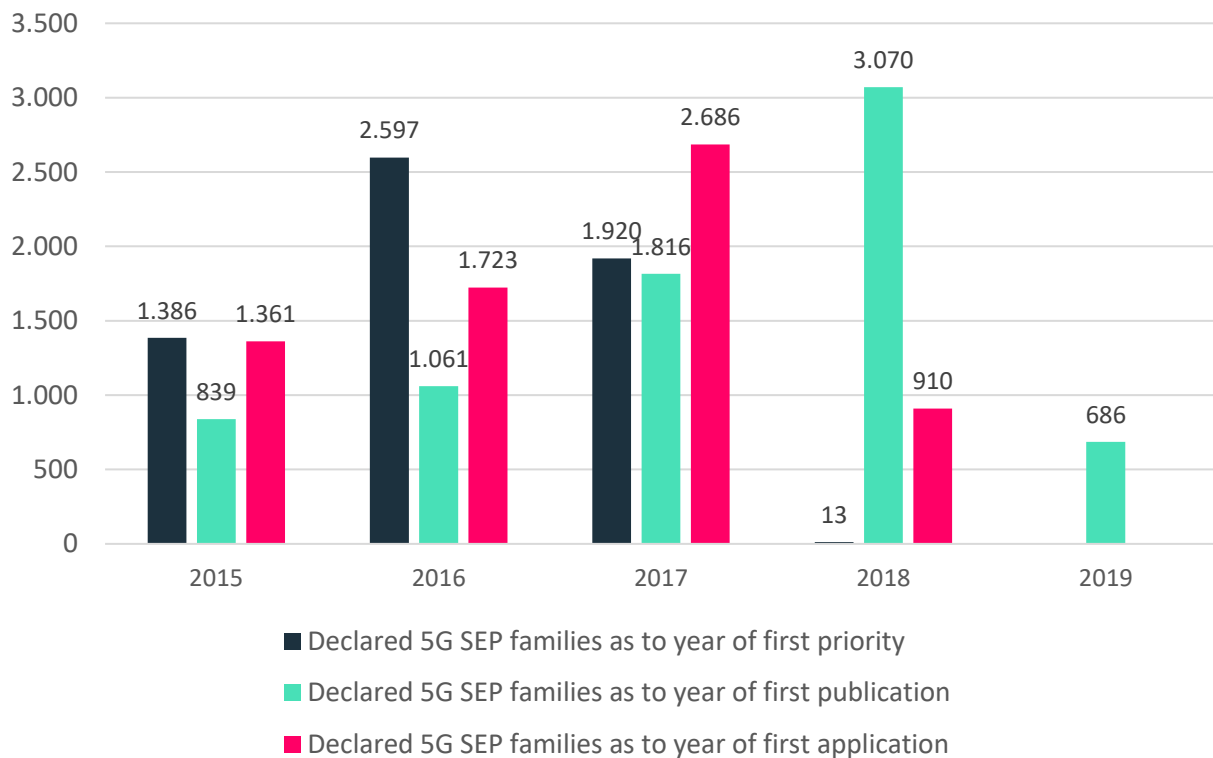
Figure 1. Data integration of patents, declared SEPs, standards and contributions (IPlytics Platform, July 2019)



2. 5G declared SEP trends

First, the IPlytics Platform's database and analytics were used to count 5G declared SEP families as to the year of first priority, publication and application. Figure 2 illustrates an increasing number of 5G declared SEP families over the past five years. While the numbers have been increasing since 2015, the truncation effect of patents being published several months after the first application at the patent office must be considered. Further, there is a delay in publicly declaring patents as 5G standard.

Figure 2: Yearly number of declared SEP families for 5G as to year of first priority, publication and application (as of IPlytics Platform, July 2019)



The main impact of the implementation of 3G and 4G was on the smartphone industry, whereas 5G will enable the connectivity of many objects and vehicles across the world through the IoT. Any sector subject to connectivity (eg, transport, energy, manufacturing, healthcare and entertainment) will make use

of 5G and therefore use 5G SEPs. Successful 3G and 4G patent licensing programmes have provided evidence that patent royalty incomes are highly lucrative. Further, the target market for licensing 5G patents will increase since 5G patent holders will be able to extend their licensing programmes to permit multiple uses (ie, uses other than smartphones).

Table 1 illustrates the top patent owner of 5G declared SEP families. The first column counts all patent families, the second column counts patent families where at least one patent has been filed at the USPTO, EPO or WIPO (Worldwide Patent Cooperation Treaty (PCT) application). In addition, the third column counts patent families where at least one patent was granted.

When looking at all 5G declared SEP families in the first column of Table 1, the Chinese company Huawei has the largest portfolio, followed by the Finnish company Nokia, the Chinese company ZTE and the South Korean companies LG and Samsung. Qualcomm and Intel are the largest US companies holding 5G declared SEPs, while Sharp and Fujitsu are the largest Japanese companies to do so. The order of patent portfolio size is similar when counting families that have been filed internationally (at the USPTO, EPO or under the PCT). However, when counting granted patent families, Nokia's portfolio is the largest, followed by Samsung and LG. The Chinese companies Huawei (28%), ZTE (5%), China Academy of Telecommunication and Technology (CATT) (8.5%) and OPPO (16%) seem to have very low grant rates as of July 2019. However, the granting process may take several years. Since 5G is a recent technology, patents may have been filed very recently, but it can be assumed that many of the 5G declared patents will be granted in the future.

Table 1: Top patent owner of 5G declarations as to the number of patent families (IPlytics Platform, July 2019)

Declaring company	5G declared patent families	Filed at USPTO, EPO or under PCT	Granted
Huawei Technologies	2,160	1,545	608
Nokia (incl Alcatel-Lucent)	1,516	1,484	1,134
ZTE Corporation	1,424	1,014	74
LG Electronics	1,359	1,339	1,100
Samsung Electronics	1,353	1,330	1,015
Ericsson	1,058	1,046	525
QUALCOMM	921	905	536
Sharp Corporation	660	635	374
Intel Corporation	618	600	62
CATT	552	332	47
Guangdong OPPO M Telec	222	208	36
InterDigital Technology	48	48	17
KT Corporation	42	31	5
ETRI	30	27	10
BlackBerry	20	19	20
Fujitsu	20	7	18
Apple	15	15	3
Sony Corporation	14	14	14
MediaTek	14	13	12
ITRI	11	10	9
ASUSTeK Computer	8	8	5
NEC Corporation	7	7	1

In order to get a better understanding of the age of 5G declared patent families, the IPlytics Platform was used to create additional counts of patent portfolios, as presented in Table 2. The first column again shows the total number of 5G declared patent families. The second column provides the average age of the patent portfolio as of the application year. When looking at the average age, Nokia seems to hold the oldest portfolio, which is on

average 11 years old followed by Qualcomm with a 5G declared portfolio with an average age of 10 years. The Chinese companies ZTE, OPPO and Huawei all have considerably young 5G declared portfolios, which could also explain the low grant rates of the previous analysis. Also, Intel has rather recently filed patents declared essential for 5G.

Table 2: Top patent owners of 5G declarations as to the age of the portfolio (IPlytics Platform, July 2019)

Declaring company	5G declared SEP families	Average age as to application year	Percentage with priority before 2012	Percentage declared to 4G or 3G before
Huawei Technologies	2,160	5,61	12,13%	35,60%
Nokia (incl Alcatel-Lucent)	1,516	11,42	57,45%	79,01%
ZTE Corporation	1,424	3,06	0,49%	1,03%
LG Electronics	1,359	6,99	43,05%	63,31%
Samsung Electronics	1,353	8,63	47,89%	77,66%
Ericsson	1,058	8,36	33,74%	70,90%
QUALCOMM	921	10,40	36,26%	74,92%
Sharp Corporation	660	6,56	29,55%	53,16%
Intel Corporation	618	4,74	0,16%	76,46%
CATT	552	2,96	0,00%	0,00%
Guangdong OPPO M Telec	222	4,23	15,77%	0,00%
InterDigital Technology	48	9,75	23,26%	82,85%
KT Corporation	42	1,58	0,00%	0,00%
ETRI	30	7,69	23,33%	69,93%
BlackBerry	20	9,65	100,00%	91,67%
Fujitsu	20	8,92	40,00%	0,00%
Apple	15	5,03	20,00%	35,44%
Sony Corporation	14	8,53	85,71%	89,25%
MediaTek	14	3,61	0,00%	0,00%
ITRI	11	4,50	18,18%	0,00%
ASUSTeK Computer	8	3,02	0,00%	0,00%
NEC Corporation	7	4,00	14,29%	0,00%

According to interviews with engineers that are members of 3GPP, it can be assumed that the main ideas concerning the new 5G technologies were

invented in the past 5 years and thus after 2012. The IPlytics Platform was again used to calculate the percentage of patents where the priority year (ie, the year when the invention was first sent to the patent office) of the declared patent family was before 2012 (third column of Table 2). Here, Nokia (57%) has a high share of 5G declared patent families, where the earliest priority was before 2012. In comparison, ZTE, CATT and Intel have 5G declared patents that were mostly invented after 2012 (eg, within the time period that is considered the most likely to include new 5G inventions).

Finally, the IPlytics Platform tool was used to identify 5G declared patent families where at least one patent has already been declared to previous standards generations such as 2G, 3G or 4G. Of the 5G declared patent families owned by Nokia, 79% have already been declared to earlier standards generations. Samsung (77%), Intel (76%) and Qualcomm (74%) have similar high percentages of previously declared patents to earlier generations. However, one must consider that technologies among generations of standards may overlap. Even Intel's considerably young portfolio has a high share of declared patents that were also declared to earlier standards generations (76%). In other words, newly patented inventions from the past five years may still be relevant to both 4G and 5G.

3. 5G declared SEP valuation

The IPlytics Platform makes use of statistical patent valuation indicators to analyze the strengths, weaknesses and positioning of patent portfolios. In close cooperation with the Technical University of Berlin, Mines Paris Tech and Northwestern Chicago, IPlytics uses scientifically validated methods to calculate relevant patent valuation indicators. In order to compare different patent portfolios, the statistical indicators are normalized by averages of patent control groups at the same patent office, International Patent Classification (IPC) or Cooperative Patent Classification (CPC) class and publication year. A patent from 2010 that was filed in the United States with the IPC/CPC H04W that receives six forward citations is compared to the average forward citation counts of all US/2010/H04W patents. If the forward citation count is six and the average is three then the statistical indicator is two - a value twice as high as average.

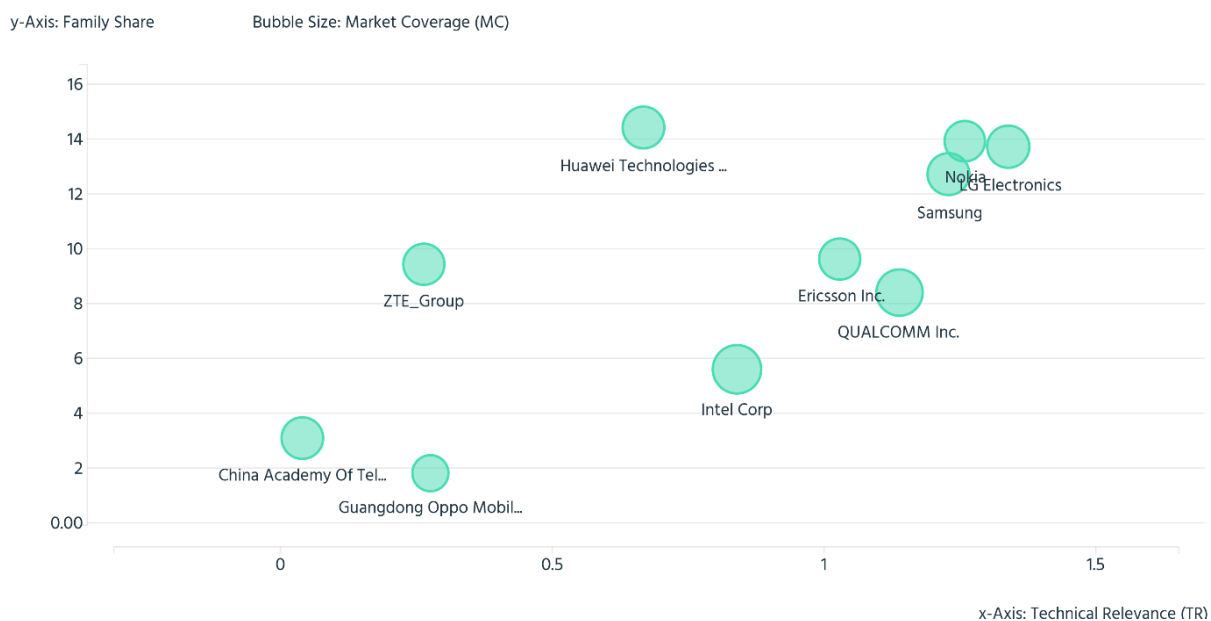
The technical relevance (TR) indicator is calculated by counting the number of prior art citations that a patent receives (forward citations). Citations are counted as citing families. Self-citations as well as subsidiary citations are not counted. Finally, counts are normalized by year, country of jurisdiction and main IPC/CPC.

The market coverage (MC) indicator is calculated by counting the number of countries in which the patent has been filed (jurisdiction) and weighted by the country's gross domestic product. Finally, counts are normalized by year, jurisdiction and main IPC/CPC.

Figure 1 illustrates the patent portfolio valuation of declared 5G patent families as to the market coverage and technical relevance indicators. The y-axis describes the share of declared 5G families as to all-declared 5G families, the x-axis shows the average normalized number of forward citations (technical relevance) and the size of the bubble demonstrates the patent family size (market coverage). The companies LG, Samsung and Nokia have the highest

TR values while the Chinese Academy of Telecommunications and Technology (CATT), OPPO and ZTE have rather low technical relevance (TR) values. A high TR value reflects the high technical relevance of a patent portfolio, since subsequent patents had to cite the patent portfolio as prior art. As the counts are normalized by year the portfolio age does not bias the results. Patent citations are reviewed and verified by objective and qualified patent examiners. A high TR value thus identifies leading technologies of a particular market segment. On the other hand, low TR values reflect the low technical relevance of a patent portfolio, since subsequent patents did not cite the portfolio as prior art. A low TR value reflects that a patent either protects a niche technology or a technology that is not relevant to other market participants.

Figure 1: Patent portfolio valuation of declared 5G patent families (IPlytics Platform, July 2019)



Intel, Qualcomm and Huawei have the highest MC values. A high MC value reflects a global internationalization strategy and wide market protection. Further, a high MC value reflects a high perceived patent value for the applicant. Patent application and patent maintenance fees create considerable costs at each patent office. The more countries in which patents have been filed, the higher the perceived international market potential for the patented



invention. A low MC reflects a local internationalization strategy and a narrow legal market protection. The fewer countries in which a patent has been filed, the lower the perceived international market potential for the patented invention. Here the Chinese Academy of Telecommunications and Technology (CATT) and OPPO yet peruse a rather local strategy.

4. 5G standard contributions

The interconnectivity of different systems and the communication across multiple devices relies on a common specification of the 5G standards. Standards development of complex technologies such as 5G therefore often integrates many patented solutions. Beyond the patent data analysis, it is also worth taking a look at the companies that are actively involved in 5G standards development. The 5G standard is specified in international meetings where companies present and submit technical contributions.

Using the IPlytics Platform's database and analytics, Table 3 shows all those companies that declared 5G SEPs to then analyze if they have also submitted technical contributions to 5G (companies that have not yet submitted 5G-relevant SEP declarations were excluded). Huawei is responsible for most 5G contributions, followed by Ericsson, Nokia, Qualcomm and Samsung.

Standards contributions are in many cases not submitted by one, but a group of companies. The first company is mainly responsible for the contribution; it then teams up with other companies to submit the input. In Table 3, the contributions in the first column are counted for all companies that have been in a group that submitted the standards contribution. The second column in comparison only counts contributions for the first contributing company. Although the counts are reduced, the general order of companies remains the same.



A different way of counting contributions made by multiple companies is to calculate the share of the contribution. For example, if there are four companies submitting a contribution together, each company will receive a pro rata value of 0.25. The third column represents the counts of proportionate standard contributions, (ie, how many contributions the company contributed proportionately). After applying this weighting, Ericsson has submitted more pro rata standard contributions than Huawei for 5G, since Ericsson has apparently made many standard contributions alone or in smaller groups, while Huawei has submitted standard contributions together with many other companies (often also subsidiaries such as Hisilicon).

Table 3: Top companies submitting technical contributions for 5G standards (IPlytics Platform, July 2019)

	Number of 5G contributions	As to first contributor	Weighted	In relevant groups	Approved
Huawei (CN)	13.155	11.989	8.359	7.066	3.961
Ericsson (SE)	10.528	9.398	9.027	5.541	3.588
Nokia (incl Alcatel-Lucent) (FI)	8.103	6.851	3.829	4.573	2.673
QUALCOMM (US)	4.087	3.278	3.176	2.602	1.267
ZTE (CN)	3.221	2.532	2.409	2.027	808
Samsung (KR)	3.158	2.494	2.403	2.233	867
Intel (US)	2.516	1.989	1.889	1.751	652
LG Electronics (KR)	1.787	1.387	1.314	1.411	467
CATT (CN)	1.786	1.410	1.395	1.240	383
MediaTek (TW)	759	562	563	645	216
NEC (JP)	703	456	487	456	206
OPPO (CN)	517	392	379	470	82
ETRI (KR)	434	264	277	345	108
Cisco (US)	346	235	226	241	113
InterDigital (US)	229	68	92	211	59
Sharp (JP)	212	174	180	211	73
KT Corp (KR)	161	1	43	70	32
ITRI (TW)	73	36	40	71	15
Fujitsu (JP)	67	27	34	36	13



Apple (US)	66	47	36	63	14
BlackBerry (CA)	60	49	47	60	20
ASUSTeK (TW)	32	30	29	22	1
Sony (JP)	4	0	0	0	1

The 3rd Generation Partnership Project (3GPP) (ie, the consortium that develops the 5G standard) is divided into several sub-groups that each work on different technical matters. Not all of these groups are working on technologies that are relevant to mobile phones or Internet of Things (IoT) devices. For example, the work in the RAN3 group specifies the interfaces between infrastructure equipment only. RAN1, RAN2, RAN4, SA2, SA3, SA4, and CT1, on the other hand, define specifications relevant to mobile phones or other IoT devices only. The fourth column of Table 3 thus includes contributions submitted in these groups only. Again the group filtering changes the 5G contributions counts for each company.

Standards contributions must be accepted and approved by the 3GPP in order to be included in the final 5G specification. The fifth column counts standards contributions approved by 3GPP members only. Overall, about 10% of all contributions have been approved for 5G. Most of the approved contributions have been submitted by Huawei, closely followed by Ericsson and Nokia. Samsung overtakes ZTE for approved contributions compared to the overall numbers.

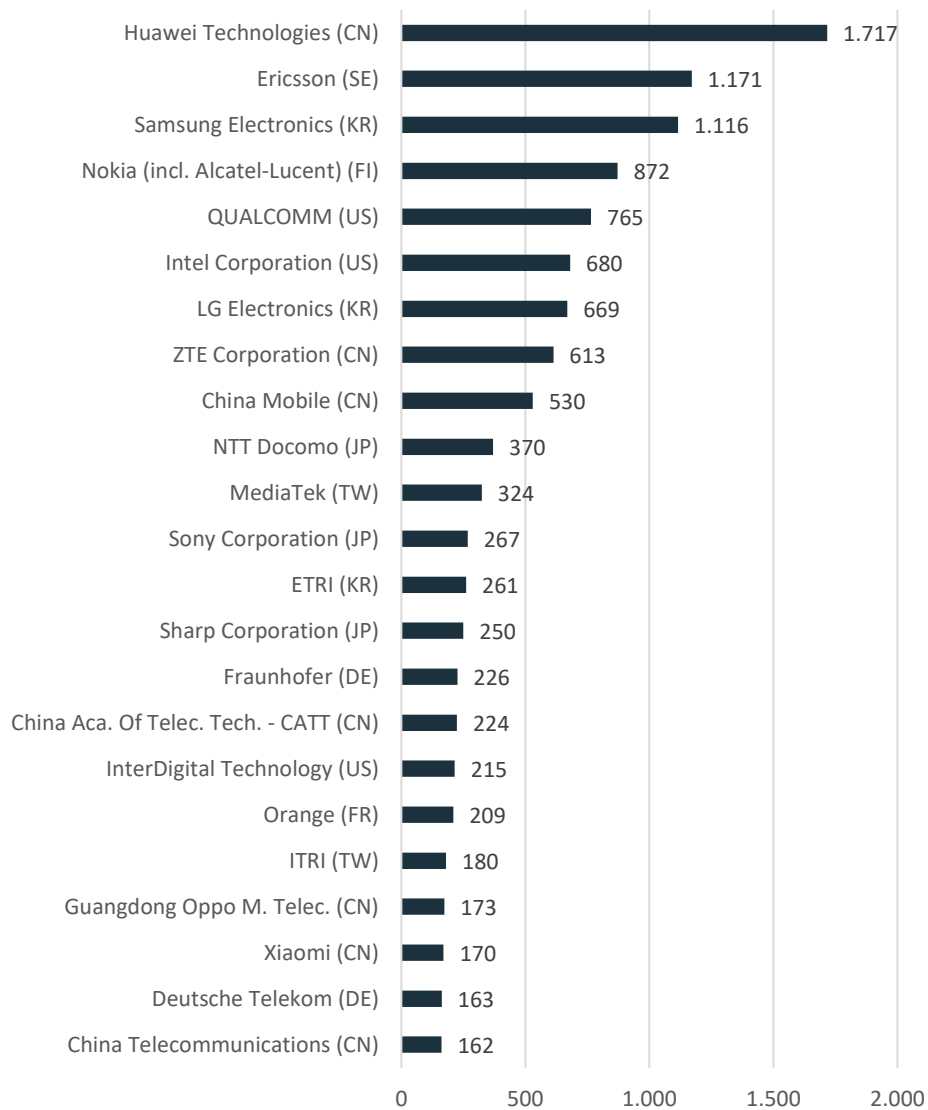
Another measure used to estimate involvement and investment in 5G standards development is the attendance of engineers at the standards-setting meetings where 5G standards are developed. Attending these meetings reflects a company's investment, as it shows that it has highly skilled technical engineers who commit their time to prepare, travel and discuss the latest 5G technologies.

Figure 4 illustrates the number of employees per company that attend the 5G standards-setting meetings. Each attendant is counted for each meeting. Huawei has sent the most employees to 5G-related meetings and thus spends



a lot of resources to attend the worldwide 3GPP RAN meetings, followed by Ericsson, Samsung, Nokia and Qualcomm. However, a few companies that are not among the top patent declaring or standards contributing companies have attended many meetings (eg, NTT Docomo, Fraunhofer and Orange).

Figure 4: Top companies as to their attending employees at 5G meetings (IPlytics Platform, July 2019)





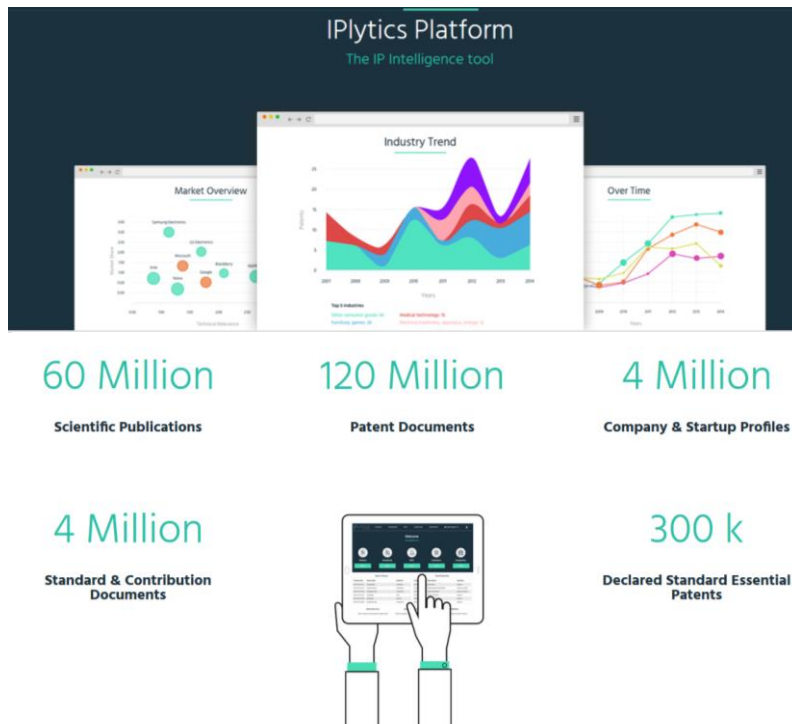
5. Outlook

The licensing of 5G SEPs looks set to become a major issue not only for the handset industry, but for any manufacturing sector where connectivity will matter. Senior patent managers and patent directors should bear the following in mind about 5G patents:

- Future technologies that enable connectivity will increasingly rely on patented technology standards such as 5G.
- The number of 5G SEPs is constantly rising - patent directors should consider royalty costs and appropriate security payments in advance.
- Patent directors should not only consider information retrieved from patent data, but also monitor and consider standardization data such as technical contributions and meeting attendance to understand the landscape of 5G patent holders.
- Senior patent managers should bear in mind the dynamic market of SEPs, where patent assertion entities often acquire patent portfolios to assert extensive royalty payments.
- Manufacturers should pursue a common strategy for patenting and standardization to ensure that they are fully engaged in developing future connectivity technologies.



About IPLYtics Platform:



IPLYtics Platform is an IP intelligence tool that augments the analysis of technology landscapes and a company's competitive position. IPLYtics Platform goes beyond patent data by linking and processing more than 120 million patents to 4 million standards, 300,000 standard-essential patents, 60 million scientific articles and the profiles of 4 million companies and start-ups on one platform.

IPLYtics Platform helps users to perform analysis in the patent valuation, patent essentiality analysis and patent and standards landscaping fields, as well as trends in patent transfer or litigation information. The intuitive graphical interface allows users to easily navigate, analyze and drill down into full-text information, enabling in-depth technology analysis or a long-term monitoring of market segments.

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