

Determining which companies are leading the 5G race

There has been much reporting in recent months on which companies own the largest portfolios of 5G SEPs, but many studies are too simplistic and may not provide a full picture of who is in the lead

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Heralded as a game-changing development, 5G has the potential to disrupt many industries – from automotive to medical – and could be key to ushering in the fourth industrial revolution. Assessing which companies are leading the development of 5G is of immense interest right now, both commercially and politically; to capitalise on this, a number of analytics firms have recently published reports attempting to rank each company's contribution to 5G.

An editorial published on the *LAM* website on 6 May 2019 by Joff Wild entitled "Patent quality, not quantity, is what really counts when it comes to standards essentiality" drew attention to a proliferation of articles arguing that Chinese companies such as Huawei have a huge lead over long-established western players such as Nokia, Ericsson and Qualcomm, as well as relatively newer entrants from South Korea, such as Samsung and LG Electronics.

The question of which company might be leading in the 5G patent race has come to the fore in part because so many third-party patent intelligence offerings are studying the numbers. We have our own patent intelligence offering which we use to evaluate telecommunications patent portfolios in international licensing disputes. For this article we applied it to assess the accuracy of the claims that are being made on 5G leadership and concluded that some published studies are overly simplistic and unreliable.

There is a clear tendency in these reports to provide insufficient information about methodology for the reader to know exactly what is being measured. In some cases, reports label data erroneously or imprecisely. Although we do not suggest that these companies are setting out to mislead their audience, the reports (especially those that suggest that China is leading the 5G race) are being picked up by mainstream news outlets, which have only added to the misrepresentation. This has had the effect of popularising an incomplete and potentially inaccurate picture of 5G leadership.

This article demonstrates that rankings of 5G leadership are extremely sensitive to the assumptions made during the analysis and the metrics used. We have not attempted to cover all of the different possible assumptions and do not claim that any of our specific results provide a more or less accurate or informative assessment of 5G leadership. The purpose of this article is to demonstrate that with relatively small changes

or improvements to the methodology, it is possible to produce very different results. However, unlike other reports on 5G leadership, we explain what we did and the data that we used. Further, we report the results from a number of different metrics, rather than picking one and implying that it alone gives a reliable ranking.

Our conclusion is that assessing 5G leadership accurately is not a simple task and requires a more sophisticated and transparent analysis than some of those recently published.

Essentiality audits are necessary to estimate 5G leadership

The theory behind assessing technology leadership through patent analytics is that companies use the patent system to protect their inventions. Patents are examined for novelty and inventiveness (ie, their validity) by independent patent examiners; measuring patents provides an estimate of the quantity (and even quality) of a company's inventions.

Even outside 5G, this sort of analysis is notoriously tricky. Simple counts of patents make the (incorrect) assumption that all patents are of equal value, while more sophisticated methods can be complex and difficult to get right. When it comes to 5G the task is complicated by the fact that 5G technology is complex and multi-layered. Differentiating between a patent that is truly essential to 5G and one that is merely related to 5G is extremely difficult, even for experts, as the subject matter of the patents can be very similar.

To try to capture just the essential 5G patents (ie, the SEPs), many studies of 5G patent leadership rely on publicly available declarations made to standards bodies. However, unlike the question of validity, there is no independent assessment of essentiality. Some degree of over-declaration is inevitable because companies are required to declare patents that *may be* essential. However, studies that rely on declarations assume that only truly essential patents are declared or that there is no variation in declaration accuracy between companies. Audits of essentiality on a company-by-company basis (such as those used in court cases) have demonstrated that this is not the case. Therefore, any study that fails to apply essentiality weightings (preferably from a detailed and well-executed essentiality audit) is simply guessing as to 5G leadership and cannot be relied on.

Unwired Planet v Huawei essentiality score

In *Unwired Planet v Huawei* ([2017] EWHC 2988 (Pat)) both parties presented evidence on actual essentiality rates for patents declared essential to 4G. Earlier studies on 2G and 3G, which found the overall essentiality percentage to be around 28%, were relied upon for those standards. David Cooper reviewed 38 Samsung and 30 Huawei patents and concluded that the essentiality rate of the Samsung patents (excluding optional features) was 15.9%. For the Huawei patents he concluded that the essentiality rate (excluding optional features) was at most 9.4%.

Huawei's expert, Apostolos Kakaes, also oversaw a 4G study, which resulted in an overall essentiality of around 35%, putting forward

specific percentages of 43.5% for Huawei and 23.5% for Samsung. We have used Cooper's results as:

- he spent between five and six hours per patent family, whereas Kakaes spent only 30 minutes per patent; and
- Justice Birss concluded that Cooper's study was a reasonable effort to assess the essentiality rates of Samsung and Huawei.

We have applied Cooper's Huawei's score to Huawei and have used Samsung's score as a proxy for the industry average: although this was the approach approved by the judge in the case, in reality each of the other companies' essentiality

score will deviate from the average and some will do better and others worse as a result.

It would also be better to use 5G rather than 4G essentiality scores, once data on this becomes available. However, using 4G essentiality ratings is a reasonable proxy for 5G if one assumes that each company's declaration policy, and its rate of over or under-declaration, remains consistent between generations.

However, the purpose of this exercise is to illustrate whether rankings are significantly affected if one allows for essentiality weightings which exhibit the degree of variability which is found in practice. Cooper's *Unwired Planet* 4G data is sufficient for that purpose

In the English High Court's judgment in *Unwired Planet v Huawei*, essentiality scores for both Huawei and Samsung's 4G portfolios were put forward (see boxout).

The ranking in Figure 1 can be compared to that in Figure 2, where no essentiality filter has been applied.

It swiftly becomes apparent that the application of this filter alone would reverse the widely reported view that Chinese companies are leading the 5G patent race.

For the remainder of the graphs in this article, only the companies from Figure 1 have been plotted (ie, the top nine companies by raw declaration count). All of the graphs in this report that show patent families or applications use the date of 1 April 2019 when calculating which company owned each patent family or application.

Valuation methodologies used in court are more sophisticated than simple counts

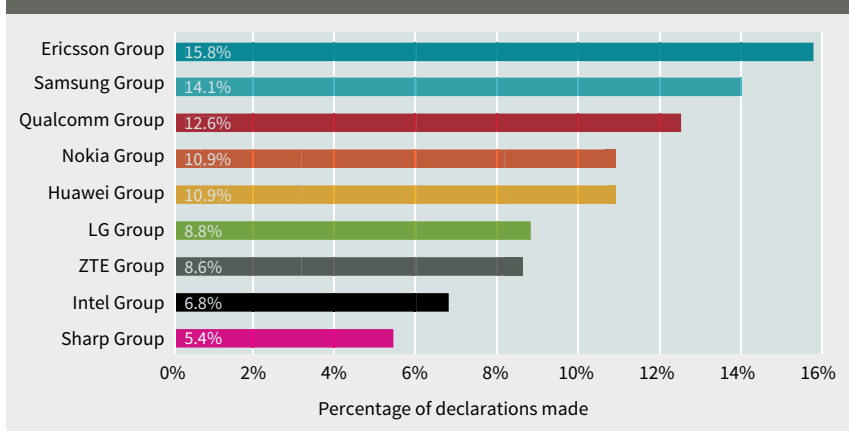
Figure 3 illustrates a count of patent families declared to the 5G standard using both the essentiality filter from Figure 1 and another filter from *Unwired Planet*, which is the requirement for each patent family to be filed in either the United States or Europe or both. Although not ultimately relied on in the final decision, the judge opined that this filter was a sensible measure, given that "a serious player in the telecommunications market, including a major Chinese company, would likely file essential patents in the US and/or Europe".

Again, the addition of this filter significantly changes the rankings, compared to Figure 1.

There are many legitimate ways to count patents and they all give different rankings

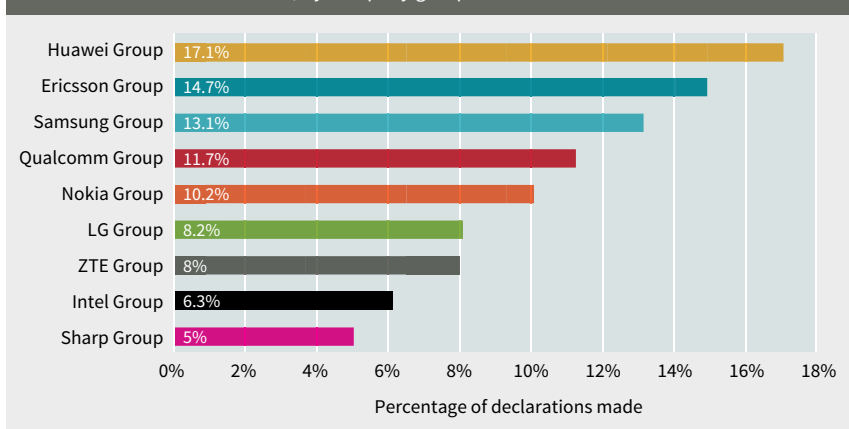
The simplest measure of leadership in a standardised technology such as 5G is to count the raw number of declarations made to the standards body by each company. While this is easy it is also overly simplistic, especially if no essentiality weighting is applied. A more sophisticated method is to count unique declared patent families, rather than raw declarations. This method is often used to control companies declaring multiple family members or declaring the same family separately to different 5G specifications and projects. However, this technique is potentially flawed for two reasons. First, there is more than one definition of a patent family and

FIGURE 1. 5G declarations with essentiality weighting, by company group



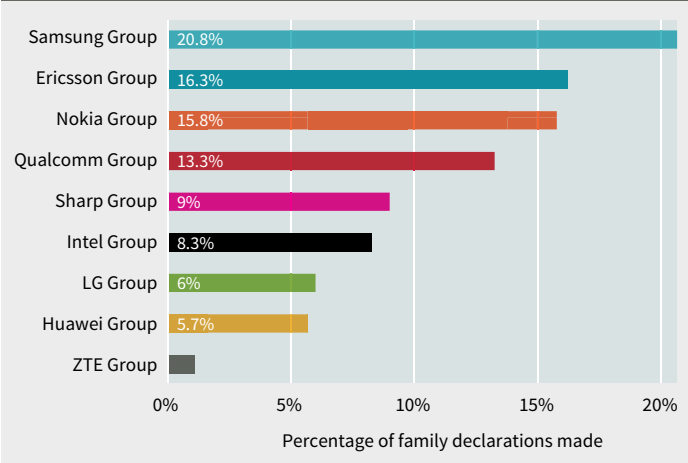
Count of raw disclosures to 5G-only technical specifications or projects by company group, filtered to 1 October 2018 by declaration date, using a European Telecommunications Standards Institute (ETSI) download from April 2019. Essentiality scores from *Unwired Planet* have been applied.

FIGURE 2. Raw 5G declarations, by company group



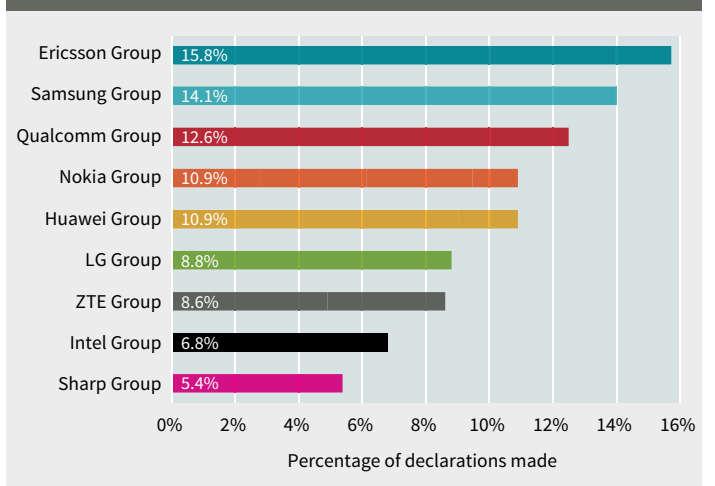
Count of raw disclosures to 5G-only technical specifications or projects by company group, filtered to 1 October 2018 by declaration date, using an ETSI download from April 2019.

FIGURE 3. Distinct declared 5G patent families, with essentiality and jurisdiction filters applied, by company group



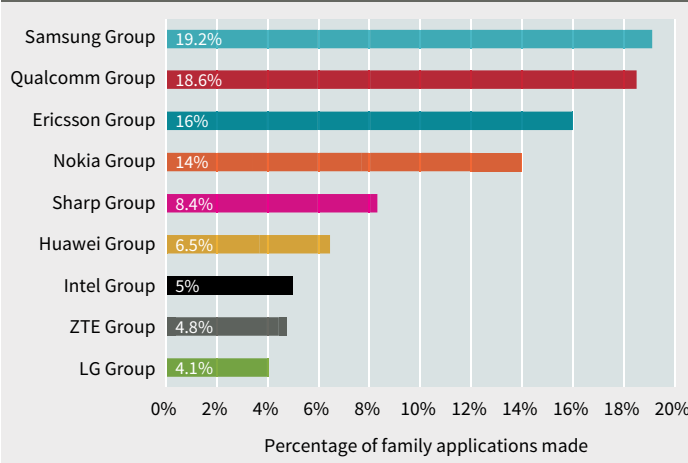
Count of international patent documentation (INPADOC) families declared to 5G-only technical specifications or projects by company group, filtered to 1 October 2018 by declaration date, using an ETSI download from April 2019, matched to EPO patent data (PatStat Autumn 2018). Filters from *Unwired Planet* applied: essentiality scores and US/European family member requirement.

FIGURE 4. Raw 5G declarations, by company group



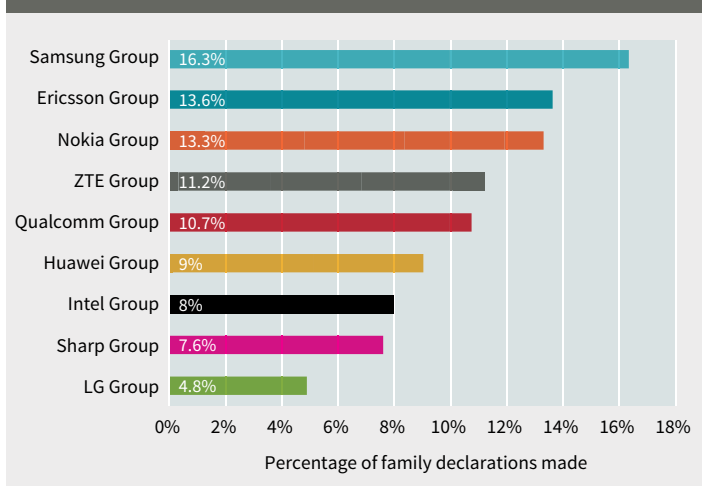
Count of raw disclosures to 5G-only technical specifications or projects by company group, filtered to 1 October 2018 by declaration date, using an ETSI download from April 2019. Essentiality scores from *Unwired Planet* have been applied.

FIGURE 5. Applications in declared 5G families, by company group (excluding multiple filings in the same country)



Count of unique jurisdictions for INPADOC patent families declared to 5G-only technical specifications or projects by company group, filtered to 1 October 2018 by declaration date, using an ETSI download from April 2019, matched to PatStat Autumn 2018. *Unwired Planet* essentiality filter applied.

FIGURE 6. Declared 5G patent families, by company group



Count of distinct INPADOC patent families declared to 5G-only technical specifications or projects by company group, filtered to 1 October 2018 by declaration date, using an ETSI download from April 2019, matched to EPO patent data (PatStat Autumn 2018). Essentiality scores from *Unwired Planet* have been applied.

using different definitions can produce different results. Second, when it comes to 5G, a significant share of the patent applications have been filed in the past 18 months and have thus not yet been published. This in turn means that they have no publicly available family data and drop out of any family count.

Another common measure used to assess patent leadership is to count the number of applications in the patent families that have been declared to a standard. This method accounts for the fact that some families are much bigger than others (and, arguably, more

valuable – at least in one dimension). Without this measure, a family with a single member and a family with 1,000 members are assumed to have the same value. However, solving this problem remains complicated for several reasons:

- correlating value with family size is not straightforward;
- the measure is subject to the same issues as family counting (eg, ignoring unpublished patents); and
- multiple patent family members can be filed in the same country, which affects value in a different way

as compared to when additional family members are filed in new countries.

A tweak that attempts to control for the third issue is to measure the geographic coverage of each declared patent family (so that multiple patents in a single country in the same family do not each contribute to the score) by filtering out duplicate patent family members filed in the same country. This is what we have done in Figure 5.

In 5G it is not clear whether counting declarations, applications or families provides a more accurate picture of 5G leadership and they all give different rankings. A report that does not attempt to show the variation between these measures or which fails to clarify which metric it is reporting implies an unjustified certainty in the results.

Figures 4, 5 and 6 show the company rankings when counting declarations, applications (excluding multiple filings in the same country) and patent families, respectively.

Existing assessments of declaration leadership are inaccurate

Most 5G leadership reports that deal with patents rely on the declaration database managed by the European Telecommunications Standards Institute (ETSI). A download of ETSI's database on any given day will include declarations made in the previous month, making it tempting for analyst firms to assume that the data is up to date and can be relied on. Unfortunately, there is a time lag between a declaration being made and it appearing in the database and this can differ for every declaration.

If the delay between declarations being made and appearing in ETSI's declaration database affected all companies equally, it would be less problematic. However, because the lag affects each company

differently, it creates a bias in any data that relies on declaration counts without a date filter. This is apparent in Figure 7 below.

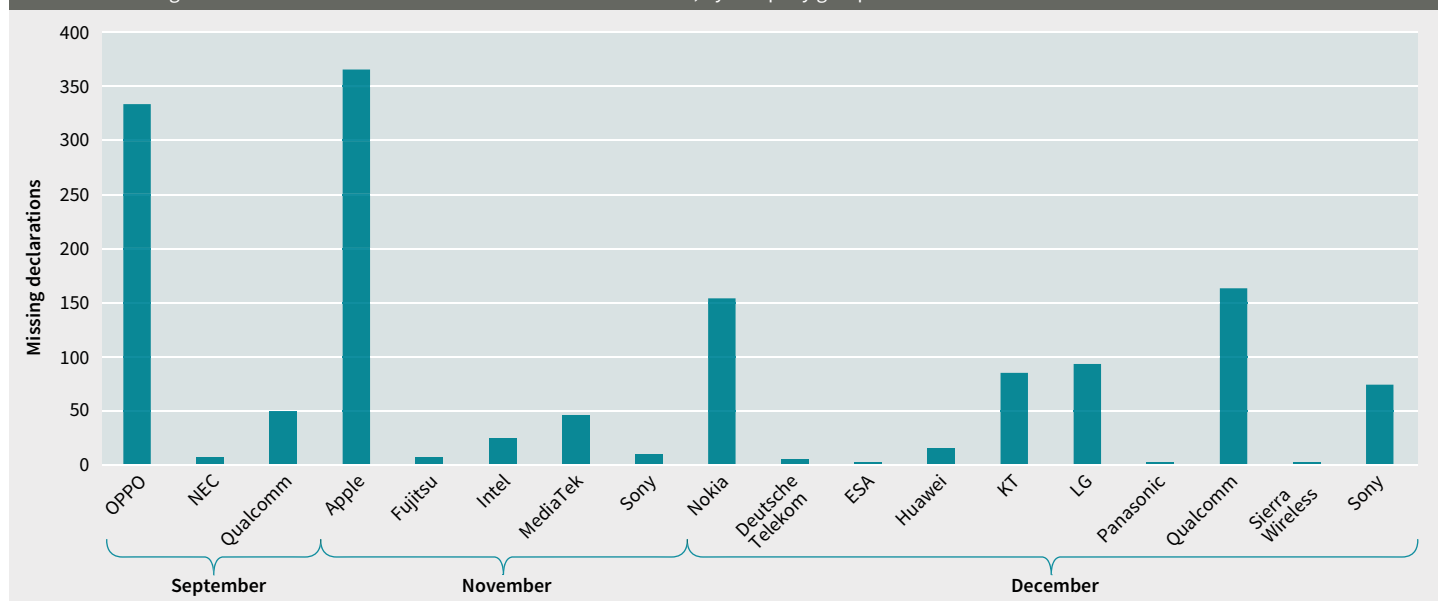
We have not seen any report on 5G leadership that attempts to deal with this lag and the resulting errors. One way to tackle it is to filter declaration data back to a date in the past, where one can be confident that all the declarations made before that date are reflected in the database. We estimate that the declaration data must be filtered back by approximately six months to eliminate this error (we have filtered to 1 October 2018). However, filtering out the most recent six months of declarations introduces new problems, because it is relatively early days for 5G and company rankings are still changing rapidly.

“Any study that fails to apply essentiality weightings is simply guessing as to 5G leadership and cannot be relied on”

Company ranking is highly sensitive to analysis date

Figure 8 plots each company's 5G ranking by simple declaration count using the data filtered back to three different dates: 1 September 2018, 1 October 2018 and 1 November 2018. Across these three dates the company rankings change significantly. For example, LG moves from fifth to sixth to second in just two months. This shows that even after removing the effect of lag, an analysis of 5G leadership is extremely sensitive to the date of the analysis and too much weight should not be placed in a study that looks at a single snapshot in time.

FIGURE 7. Missing declarations in the ETSI database as of 31 December 2018, by company group and month



Number of declarations made between 1 September 2018 and 31 December 2018 which were missing from an ETSI download made at the end of 2018 (as compared to an ETSI download from the start of April 2019).

FIGURE 8. Company group ranking by simple declaration count, using declarations made in September 2018, October 2018 and November 2018

Ranking	September 2018	October 2018	November 2018
1	Ericsson	Ericsson	Ericsson
2	Samsung	Samsung	LG
3	Huawei	Qualcomm	Samsung
4	Qualcomm	Nokia	Huawei
5	LG	Huawei	Qualcomm
6	Sharp	LG	Nokia
7	Intel	ZTE	ZTE
8	N/A	Intel	Intel
9	N/A	Sharp	Sharp

Company rankings by count of raw declarations to 5G-only technical specifications or projects by company group, filtered by declaration date to specified months. Declaration data is from an ETSI download from April 2019. Essentiality scores from *Unwired Planet* have been applied.

This data also shows that companies that are known to be leaders in 5G development have only just started to declare their patents. A prominent example of this is Nokia, which does not appear in the first column but leaps to fourth in the second column after making its first 5G declarations in September 2018. We would not be surprised if there were further declarations by such companies still to come, significantly changing the 5G declaration landscape.

“Any report on 5G leadership should include sufficient information that the results can be verified and reproduced using external sources”

It is difficult to spot the newest 5G patent applications

Many 5G features that are likely to be important and that are generating considerable interest at present have been developed relatively recently. The patent applications that relate to these are likely to be missed in any count of 5G families. This is because a patent application is not usually published until 18 months after it has been filed.

Even when these patent applications can be measured (eg, when plotting raw declaration counts) they can be outnumbered by 2G, 3G and 4G patents that have been re-declared to the 5G standard. Ideally a reliable study would distinguish between old and new 5G patents and attempt to provide measures of both. Figure 9 plots those declarations that cannot be matched to publicly available patent data, indicating that they relate to patent applications that have not yet been published.

Publication by analytics firms can be wrong, opaque or misleading

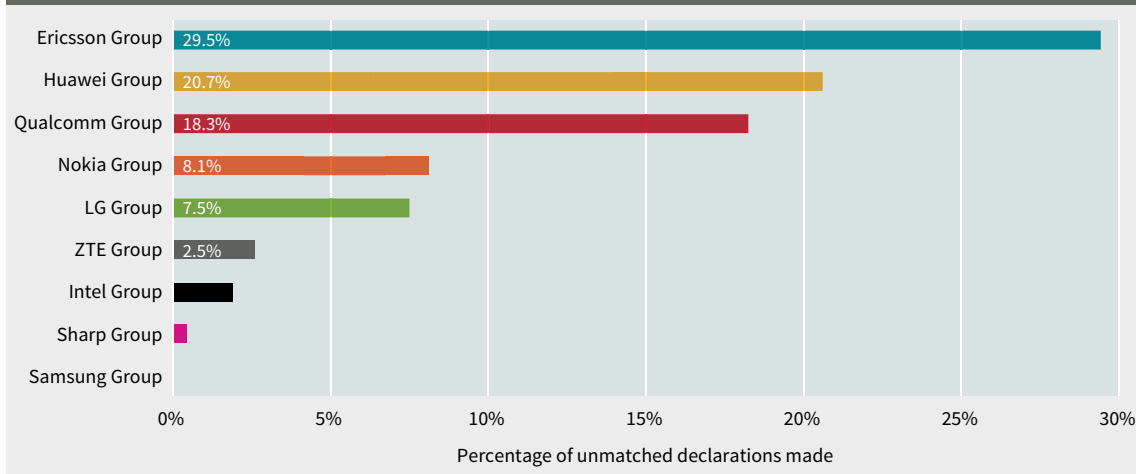
IPLYtics and Bloomberg have recently published articles on 5G leadership that contain some of the errors identified in this article.

Errors in IPLYtics data

IPLYtics is a European-based patent analytics firm with a focus on standardised technology such as 5G. It has published reports on 5G leadership and its data has been picked up in articles on 5G leadership published by CNN, the *Wall Street Journal* and Statista. We reviewed IPLYtics’ February 2019 report (it has also produced an updated report, dated April 2019). Figure 2 of both reports seeks to rank the top 5G SEP owners.

It would appear that IPLYtics’ reports suffer from the issues that have been discussed above. These can be summarised as follows:

- IPLYtics’ title for Figure 2 in its February report is “Top 5G Standard Essential Patent Owners”. This implies first that this is a count of patents and second that this is a count of essential patents. However, it does not appear that IPLYtics has assessed essentiality or allowed for different rates. This is unfortunately misleading, for the reasons outlined above. IPLYtics’ April update retitled the table as “Top 5G standard essential patent owners as to the number of patent families”, which clarified that what was being counted was families rather than patents. However, the results still appear to be a count of declared families, rather than essential families. A more accurate title would have been “top declarers of potentially 5G-essential families”.
- There is no explanation as to whether IPLYtics is counting granted patents only or whether it includes non-granted applications. The term ‘standard essential patents owners’ may suggest a count of granted patents but their numbers do not support such a filter.
- The reports are unclear as to the dates on which declaration data was acquired. The only date given in the first report is the date of the report itself (ie, February 2019). In the updated report the date is only given for the first table, which lists numbers of declarations by year (given as “as to April 2019”). It is unclear whether this date applies to the later tables. Whatever date has been used, IPLYtics does not appear to have filtered its declaration data to an earlier declaration date, meaning that its results are tainted with the bias from the lag in ETSI’s database.

FIGURE 9. Indication of 5G declared patent applications which are not yet published, by company group

Count of declarations (made to 5G-only technical specifications or projects) in ETSI's database which cannot be matched to bibliographic patent data of published patent applications. Declarations are filtered to 1 October 2018 by declaration date, using an ETSI download from April 2019, matched to EPO patent data (PatStat Autumn 2018). Essentiality scores from *Unwired Planet* have been applied.

- The reports do not make clear what source has been relied on for either the declarations (eg, ETSI downloads or the bi-annual special report published by ETSI) or the patent (bibliographic) information that needs to be used to count applications or patent families. Again, each produces different results.

We have been unable to replicate the data or the company rankings in the IPlytics reports even exploring the various permutations about choices that could have been made. It is unfortunately not possible to verify IPlytics' data without further information as to how the analysis was carried out.

Errors in Bloomberg data

On 11 February, Bloomberg published an opinion article entitled "China's 5G riches are a blocked number for investors", which claimed that "Huawei leads the world in the number of declared essential patents for next-generation wireless technology". Although the article clarified that it was reporting on declared essential patents rather than essential patents *per se*, it did not explain to readers that declaration counts do not necessarily mirror holdings of truly essential patents.

Bloomberg's analysis contains the same errors as the IPlytics data. It does not clarify:

- the date of the analysis;
- the source data relied on; or
- which metrics are used.

As a particular example, the Bloomberg article refers to counts of 5G patents but it is unclear whether it is counting declarations, applications or families.

Out in the open

With the current high level of interest in 5G and given that rankings are so susceptible to the methods and assumptions used, analysts need to be careful to

Action plan



Recent reports and articles on 5G patent leadership paint a misleading picture and typically present their results as having a greater accuracy than is warranted. Determining an accurate ranking of 5G leadership, especially at this early stage for the technology, requires transparency, the use of multiple methods of assessments, and legal and industry-specific knowledge. Here are a few things to look out for:

- Any count of 5G SEPs should include some sort of measure of essentiality.
- Focusing on patent families in the United States and Europe can be a useful tool in identifying the most significant patents.
- Calculating the raw numbers of 5G declarations, applications and patent families produces different results as to who is leading the 5G race.
- The time lag between a declaration being made and it appearing in the ETSI database needs to be taken into account as SEP counts are updated.

conduct analysis accurately and report it fairly. Reports should include, as a low bar, an explanation of what was measured, when and how. Ideally any report on 5G leadership should include sufficient information that the results can be verified and reproduced using external sources.

Even if some analytics firms prefer to keep their methodologies secret, journalists and other consumers of these reports need to be aware of the limitations and biases of any single method of analysis when reading such reports and the fact that other methods of analysis may produce a very different result. **iam**

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