Do not Count on Accuracy in Third-Party Patent-Essentiality Determinations

The Roadmap on *Standard Essential Patents for a European Digitalised Economy*[1] from the European Commission's DG Internal Market, Industry, Entrepreneurship and SMEs (DG Growth) sets out how it believes increasing transparency on standard-essential patents and its other objectives with SEPs and FRAND licensing might be achieved.

A study report commissioned by DG Growth in support of this initiative on *Transparency, Predictability and Efficiency of SSO-based Standardization and SEP Licensing* (the CRA report)[2] proposes, among various other recommendations, that declared patents and patent applications should be centrally assessed by standard-setting organizations or by the European Patent Office to determine whether they are *actually* essential to standards including those developed by ETSI for 3G, 4G and 5G.

A path to price regulation

This intervention is unwarranted and results would be unreliable. It would introduce various inaccuracies with significant subjectivity, biases and would be very costly in any attempt to do such a massive job thoroughly. Parties should be entitled to use, internally and in bilateral or multilateral agreement and in litigation with others, whatever patent-evaluation techniques they wish. That is entirely different to a particular "patent-counting" methodology and assessor being imposed.

DG Growth also headlined in its Roadmap that it would like to make SEP values and FRAND royalties clearer to prospective implementers. If it prescribes the creation of a centralized SEP assessment database, as described above, this inevitably will also lead to it being used to determine a patent owner's share of SEPs and FRAND royalties. This is problematic due to the inaccuracies described and it would also troublingly lead to the setting of prices on a company-by-company basis, which is not and should not be the role of the European Commission or instruments it controls.

Justice Birss concludes in Unwired Planet vs. Huawei[3] that "in assessing a FRAND rate counting patents is inevitable". The parties in the case did indeed use that among other valuation methods, but their respective patent counts differed very widely – for example, by a factor of five for the total number of LTE SEPs. However, the judicial process enables the court to figure out where the biases and inaccuracies lie in case-specific circumstances and make sense of differences in opinion.

Intervention with centralised essentiality assessments would be a blunt instrument that would be subject to political and other adverse influences. The regime would lack the flexibility to adapt that exists in the marketplace among companies acting independently and that occurs among parties in litigation with due process in the courts.

An impossible Holy Grail

The implicit assumption that objective and accurate determinations of portfolio essentiality, patent strength and value can be made with extensive assessments of numerous patents, or with in-depth evaluations of relatively small samples of these, is deeply flawed. Evaluating standard-essentiality is a fact-intensive, complex and highly subjective task, as is assessing patent validity and patent value.

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[1] http://ec.europa.eu/info/law/better-regulation/initiatives/ares-2017-1906931_en

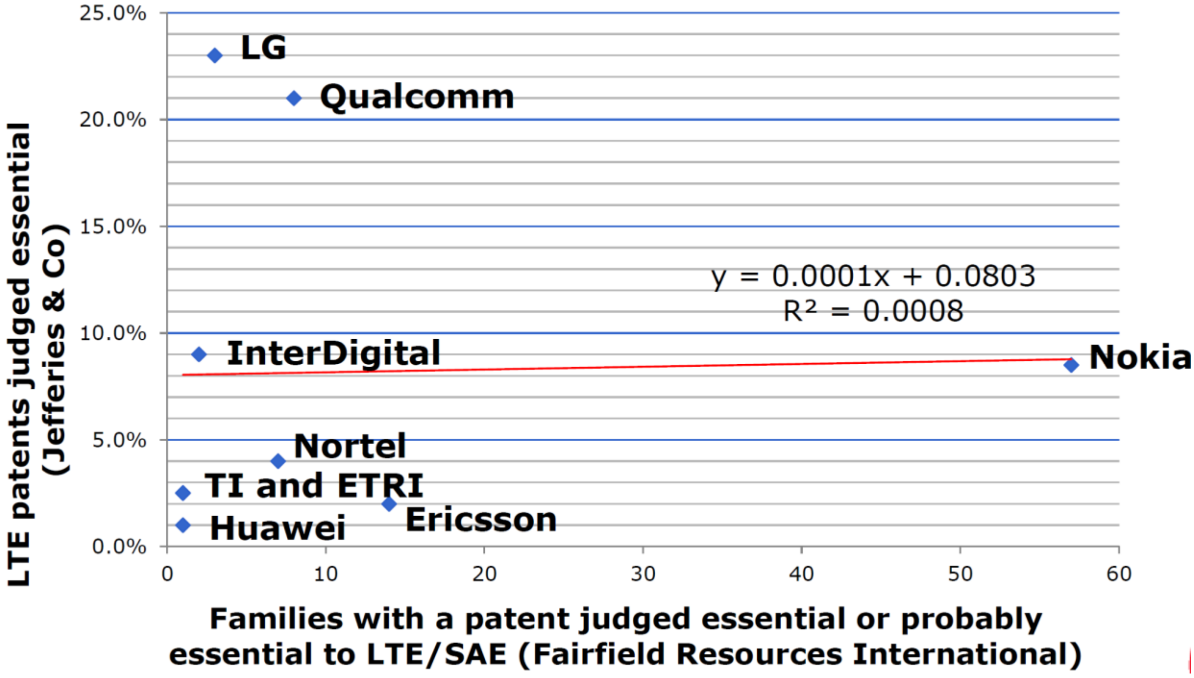
[2] http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=9028&lang=en

[3] https://www.judiciary.gov.uk/wp-content/uploads/2017/04/unwired-planet-v-huawei-20170405.pdf

Only a court of law can make definitive determinations on these issues.

The opinions of others tend to differ widely, as illustrated when comparing the results of third party "patent counting" studies in which assessors evaluate companies' shares of SEPs. I first analysed this using linear regression and measuring correlation between the results of two studies in an article I published in 2011.[4] It showed the results of the two studies from around then were totally unrelated.

Figure 1: Disagreement on LTE Essential Patent Determinations: Regression shows extremely weak correlation between two studies' results (R^2=0.0008)



Expanding my analysis to include many more publicly available studies since then also reveals very wide disparities. For instance, LG's share of LTE patents judged essential by various assessors range from 2.9 percent to 23 percent – a factor of eight. Huawei's share of judged-essential LTE patents range from 0.6 percent to 10 percent – a factor of seventeen. Nokia's share of judged-essential LTE patents range from 2.3 percent to 54 percent – a factor of 23.

Figure 2: A Few Among Many Wide Variations in Shares of Judged-Essential LTE Patents Among Patent-Counting Studies

	Lowest Estimate	Highest Estimate	Disparity
Huawei	2.9%	23%	8x
LG	0.6%	17%	17x
Nokia	2.3%	54%	23x

Portfolio-wide assessments are necessarily shallow due to the large number of patents and work required per patent. They are therefore inherently imprecise. There is no precision or certainty in determinations absent the impossibility of in-depth patent-by-patent court determinations for entire

[4] http://www.rcrwireless.com/20111116/opinion/analyst-angle-no-consensus-on-which-patents-are-essential-to-lte

portfolios of thousands of patent families.

Invalid extrapolations

Conducting in-depth assessments on relatively small samples of patents does not fix this shortcoming. The proportion of SEPs in portfolios cannot be projected from random samples of patents with the precision of predicting the results of coin tossing. Patent selections (e.g. those applicable to devices rather than networks, or which patents in a patent family) and essentiality determinations are with significant personal judgement, bias and uncertainty. Consensus is that patent values are highly skewed. Many patents are worth little or worthless because they would likely be found invalid or not infringed by a court. As shown in *Commonwealth Scientific and Industrial Research Organisation v. Cisco*, with one patent licensing at around one dollar per unit in comparison to very little for most WiFi patents, some patents are worth hundreds of times more than the average SEP in a standard. This is all probabilistic.

In other words, determining overall essentiality across thousands of patent families and among many patent owners with standards such as 4G LTE is so subjective and potentially unreliable that any assessor’s count of the number of SEPs owned by a given company is questionable. The corresponding patent strength or patent value that might be subsequently derived, in absolute terms or in relation to other patent owners, is even more contestable.

Conflicting demands, bureaucratic competence and impartiality

Authorities should only make assessments and publish figures that are reliable and can be measured reproducibly – such as “weights and measures” and in official statistics such as demographic figures and the national accounts– which SEP counts are not. Patent attributes should be assessed as they currently are in the marketplace as the market and its participants see fit, with owners’ disclosures and various third-party assessors of SEPs. Parties should also be able to consider other factors and make different assessments based on, for example, their own technical analysis of declared patents. Market forces can determine and change which standard-essential technology factors and assessments suit the market best, while bureaucracies struggle to get it right and can be very resistant to needed change. Where disputes arise, the courts can make determinations with due consideration of industry practices.

Implementers of SEP-based technologies have the legitimate concern that it can be difficult to determine exactly which patents they are infringing, from whom they must seek licenses and how much in FRAND royalties they should pay. In response, ETSI’s IPR policy requires that patent owners provide information on patents and patent applications that they believe might be essential or might become essential to standards such as 3G WCDMA and 4G LTE. ETSI does not police or audit what is submitted to its IPR database. Disclosure requirements might reasonably be increased to include more information on how patent claims map to the standards, but judging this for essentiality or commercial value is not a job for a standards development organisation or the patent office. Antitrust restrictions preclude SDOs from getting involved in valuing patents and setting licensing terms including FRAND royalty charges.

Disclosure tactics

Patent disclosures to SDOs including ETSI were purposely intended to be conservatively-large, including patents which might be or could become essential to standards, but the goalposts are being moved. ETSI’s IPR policy helps ensure that the maximum number of patents will be identified and will be available for licensing under FRAND terms. However, it also tends to result in significant over-disclosure so that patent owners can avoid penalties, such as compulsory, royalty-free licensing if they do not disclose a patent that ends up becoming essential as the patent is prosecuted and as the standard changes in its development. With so much attention on SEP counts and use of these as a proxy for portfolio patent strength and value, some companies seek to maximize the number of patents they declare to justify a relatively high royalty.

Inaccuracies, biases in determinations and company disclosure tactics, as above, are why it would be unwise for SEP determinations, SEP counts and any other counts that are used to determine patent and portfolio values to be imposed on the market.

The wisdom of King Solomon's (data) Mines

Any EC-prescribed centralized SEP assessment database tool would inevitably result in parties becoming, at least somewhat, obliged or pressured to use it to "split the baby" in determining patent owners' shares of SEPs and FRAND royalties in licensing. Established and emerging practices would be eroded or marginalized including:

- Use of comparable license benchmarks from hundreds of executed licenses and billions of dollars in royalty payments over many years,
- In-depth bilateral discussions on patent claims and how they map to the standards, and
- The counting of approved contributions to the standards.

Patent counting usefully complements these other SEP evaluation methods in licensing negotiations, but this technique should not be the bureaucratic means of setting prices on a company-by-company basis that would emerge from stipulating patent counting and emphasizing it over other valuation methods. Centrally imposed assessments would likely become increasing dysfunctional and corrupting as the system, its administrators and its operators are gamed or courted for political and commercial gain. Government agencies would do better to keep clear and let licensing parties and third parties in face of market forces decide for themselves which facts, figures and studies they would like to use in licensing deliberations and in litigation.

The rest of this article supports my conclusions by showing methodically how very inconsistent determinations of LTE essentiality and patent strength are among all the different third-party evaluators. It shows that such methods are particularly unreliable in valuing patent portfolios.

Methods for evaluating and comparing patent portfolio standard essentiality, patent strength and value

Bilateral patent licensing negotiations between technically and commercially sophisticated parties typically and justifiably include discussion of a variety of different ways of evaluating and comparing patent portfolio strength and value. To enable prospective licensees to assess the technical merit of standard-essential patent portfolios during negotiations, SEP owners may provide prospective licensees with lists of representative patent families that the company has determined are essential for a mobile device to comply with the 2G, 3G, and 4G standards, as well as representative claim charts. The potential licensee evaluates the patent owner's representative patents and claim charts (and vice versa, where both sides are standard-essential patent owners) and forms opinions regarding the merits of the patent owner's patented technology within the overall standard. These opinions inform the parties' ultimate agreement on what constitutes FRAND terms and conditions for a license.

In addition to representative patent lists and claim charts, negotiating parties may also exchange and consider third-party studies that estimate SEP ownership and patent strength for these among companies who contribute technology to the cellular standards. These studies are based on: (i) declared patent counts, judged-essential patent counts, individual patent strength determinations (i.e. "patent-counting" methodologies), or (ii) counts of approved contributions to the standards.

Patent counting is a methodology for estimating SEP portfolio strength relative to other SEP owners

The ETSI Intellectual Property Rights (IPR) database is publicly available and searchable on ETSI's website, and contains tens of thousands of IPRs (patents and patent applications) declared by companies who believe these are, or may become, essential to the standards promulgated by ETSI. Parties who engage in patent counting for the cellular standards use declarations found in the ETSI IPR database to count the number of patents that ETSI members and other companies have "declared" as potentially essential to the implementation of a specific standard or standards. An entity engaged in patent counting may then supplement its raw counts of declared patents with its own technical evaluation of the declared patents, which might take the form of an analysis into whether the counted declared patents are "seminal" or "highly essential and highly novel," or an analysis into patent "importance" or "contribution" to the standard at issue.

By searching declaration data obtained from the ETSI IPR database, it is possible to sort patents and patent applications by company that declared them (possibly) standard essential, the country or countries where the patent application was filed, the date the patent was declared to ETSI, the application and publication number of the patent (if available), and the technology that the patent is declared for (e.g. LTE, WCDMA, EDGE, GPRS, GSM). The process can finish there,[5] or, as is the case with the studies that I discuss below, further analysis intended to judge essentiality and/or technical value can be undertaken. For example, a study by the consulting firm iRunway study counts what it calls "seminal" 4G LTE patents.[6]

The individuals who conduct these assessments typically undertake to evaluate the declared patents for various attributes, including whether any of the pending or granted claims of the declared patents map to the relevant 2G, 3G, or 4G standards, and may spend from less than an hour to rather more time analysing each patent or application. Whereas in a typical license negotiation the patent holder would present a claim chart illustrating the proposed mapping of patent claims to the standard, these studies require the individual reviewing the patent to not only interpret the claims of the patent, but also determine the section of the standard that the claims may cover, and then consider how well the claims map to the particular section(s) of the standard. That can be a complex and lengthy task that is impossible to complete satisfactorily in less than an hour. Certain studies may take additional steps or analyse other factors purportedly determining patent strength, such as whether the patents are "seminal" or "highly essential" or "highly novel," although these steps are less prevalent, more varied and even more ambiguous than essentiality analysis which is the common and defining factor. Ambiguities about essentiality include how optional and obsolete features in the standard are regarded. Notwithstanding the significance of validity in determining patent value, validity assessments are rarely, if ever, included in published patent-counting studies.

The next step of a patent-counting study is to compare the results for each company's declared

[5] Microwave Journal (January 2010), *Qualcomm Takes Lead as 4G Patent Holder*, (reporting the results of an ABI Research study counting declarations to the ETSI IPR database of patents that were deemed possibly essential to the LTE standard).

[6] iRunway, *Patent & Landscape Analysis of 4G-LTE Technology (2012)*.

patents relative to other companies. The theory and proposition in portfolio licensing negotiations is that a company with more declared patents and/or patent applications (or more patents and/or patent applications judged to be essential or stronger in the analysis performed) has a more valuable portfolio than companies with fewer and weaker declared patents or patent applications.

Importantly, there are significant variations and inconsistencies among the methodologies and evaluation criteria employed in patent-counting studies. Some count patents and others count patent families. Some attempt to count issued patents and pending patent applications, while others only count issued patents. There are arguments for and against each approach. For example, some would regard counting multiple patents in the same family as double, triple, or quadruple, etc. counting. Others take the opposite view because patent claims may vary among patents within the same family. In another example, some argue that having patent protection in more nations increases overall portfolio strength and value, while others take the position that owning patents in certain geographies is what is germane to overall portfolio strength.

I have compared the results of several patent counting studies where assessors have undertaken additional analysis beyond merely counting patents that have been declared essential by their owners. I have included studies where I have been able to find those results openly available to all online publicly and for free. The scale nature and timing of those studies are summarized in Figure 3:

Figure 3: Summary of Patent-Counting Studies

Study	Universe of IPRs Considered in Study	IPRs Subject to Technical Analysis	Metric Applied in Analysis	Publication Date
Cyber 1[7]	2,999 families of declared patents and patent applications	1,147 patents evaluated	"Really essential"	Dec-2011
Cyber 2[8]	5,013 declared patents or patent families	1,601 patents evaluated	"Truly essential"	Oct-2012
Cyber 3[9]	5,919 declared patents or patent families (filed or issued patents only)	2,129 patents evaluated	"Truly essential"	Jun-2013
Article One[10]	3,116 declared patents and patent applications	All 3,116 were reviewed	"Highly-essential and highly novel"	2012

[7] Cyber Creative Institute Co. Ltd., *Evaluation of LTE essential patents declared to ETSI*, (Dec. 2011).

[8] Cyber Creative Institute Co. Ltd., Evaluation of LTE essential patents declared to ETSI, (Oct. 2012).

[9] Cyber Creative Institute Co. Ltd., Evaluation of LTE essential patents declared to ETSI, (June 2013).

[10] Article One Partners, LTE Standard Essential Patents Now and in the Future (2012).

Study	Universe of IPRs Considered in Study	IPRs Subject to Technical Analysis	Metric Applied in Analysis	Publication Date
Jefferies[11]	1,400 patents "related to LTE" screened from among tens of thousands	1,400 patents	"Essential"	Sep-2011
iRunway[12]	4,599 4G-LTE declared patents	22 parameters including infringement detectability and dependent claims, technology activity rate, backward and forward references, age of patent etc.	"Seminal"	2012
Fairfield[13]	210 families with at least one US, EP or Japanese declared patent from among 1,115 declared patents and patent applications		"Essential/ probably essential"	2009/ 2010

In addition, I considered the results of a patent-counting study conducted by PA Consulting that I have not been able to find for free online. PA makes its studies available for purchase by its clients. Unfortunately, despite my repeated requests over several weeks for permission to use its top-line study results in my analysis, no answer, one way or the other was provided by the firm. PA's study results have therefore not been included in the following analysis, but this does not affect my conclusions and opinions which apply as much to PA's results as they do to the results of the other studies.

Patent counting entire portfolios is not reliable enough for government imposition

There are structural problems that make patent counting an unreliable method for measuring the strength of a company's essential patent portfolio. ETSI does not police its database of IPR licensing declarations, which means that it is the sole responsibility of the declaring party to decide whether a patent or application needs to be declared or not. Nor does ETSI carry out any check on declarations after the fact, i.e. there is no official mechanism in place to check whether declared patents are or become, in fact, essential. This means that ETSI members may declare marginally relevant – or entirely irrelevant – patents in the belief that it is best to minimize the possibility that any of their undeclared patents might be or become essential. Alternatively, other ETSI members are anxious not to attract criticism by over-declaring patents or patent applications and thus take a more

[11] Jefferies, Research in Motion Evaluation (Sept. 2011).

[12] iRunway, Patent & Landscape Analysis of 4G-LTE Technology (2012).

[13] Fairfield Resources, Review of Patents Declared as Essential to LTE and SAE (4G Wireless Standards) Through June 30, 2009 (Jan. 2010).

conservative approach when declaring patents. The key point here is that declaring a patent or patent application to ETSI does not make the patent or patent application essential.

Another problem with patent counting is specific to declared patent applications. A patent application may undergo changes while in prosecution, and the ETSI standards are constantly evolving. So, although a company may believe its patent application discloses an invention that is or may become essential when submitting its declaration for the application to ETSI, the patent that eventually issues from that application may not read on the standard. Or the patent application may never issue at all. Or the relevant portion of the standard could change while the application is pending. This results in a declared patent application that is not essential, but that nevertheless remains a declared IPR in ETSI's on-line database.

Even when coupled with additional technical analysis, SEP determinations are not reliable

To mitigate some of these failings of patent counting set forth above, a party undertaking a patent-counting assessment may attempt to perform a technical analysis of some or all the declared patents or patent applications. This analysis typically would involve an engineer (or team of engineers) that reviews the patents and applications of the declared family, compares them to the relevant standard(s), assesses essentiality, and then possibly filters or rates the patents, patent families, or patent applications based on their significance or contribution to the standard.

While this approach might seem superficially appealing, it is unworkable to perform such an analysis effectively. An extensive essentiality analysis, if sufficient time and competent resources could be found, would be cost prohibitive. Properly evaluating a single declared patent to determine whether it is essential to a standard, let alone assessing validity or importance of the patent, would cost many thousands of dollars. Assessing essentiality for even one patent family in the context of an entire standard is an even more time-consuming and costly exercise. When a patent portfolio encompasses many patents from among hundreds or thousands of patents reading on the standard including those owned by other patent holders across multiple national jurisdictions and in several different languages, a patent-by-patent review is time and cost-prohibitive. For example, in *Microsoft v. Motorola*, Judge Robart heard from eleven experts over seven days to evaluate just six patent families.[14]

In practice, outside of a court proceeding, there is no certainty of what is technically essential and what is non-essential to a standard. The notion of exhaustively establishing with precision whether each and every patent in a portfolio of hundreds or thousands of patents is essential, let alone assessing the technical or monetary value of those patents, is simply illusory. This is recognized in a study that was commissioned by the DG Growth in 2014 to support its public consultation on Standards and Patents:

[14] *Microsoft Corp. v. Motorola*, *Inc*., No. C10-1823JLR, 2013 U.S. Dist. LEXIS 60233, *16, *82-*83 (W.D. Wash. Apr. 25, 2013).

> *One of the problems is that patent disclosures are on the basis of self-declaration. While many SSOs have rules on what must be disclosed, these rules cannot and do not guarantee that all actual essential patents are on the list or that all listed patents are actually essential. Nor do the databases provide information about the validity of the patents, the scope of the patent or about the ownership of patents. Consequently, it is not always easy for adopters to assess whether they infringe a patent and/or whether the patent is actually enforceable.*[15]

The CRA report also broadly agrees with that previous DG Growth study in its indication of how very costly it can be to assess essentiality and infringement, let alone validity, upon which the strength and value of a standard essential patent significantly depends:[16]

> *We estimate the following broad range of costs associated with essentiality tests at different confidence levels:*
>
> *(1) Approx. 600-1,800 Euro [$670-$2,000] per patent (1-3 days of work) for a first instance essentiality test performed by the SSO internally, with the confidence level appropriate for patent disclosure obligations at an SSO. (The level is often lower, as a patent in the same patent family will need fewer individual resources and because firms may possess previous information on their patents);*
>
> *(2) Approx. 5,000-15,000 Euro [$5,700-$17,000] per patent for an essentiality test performed by a third party in the context of a patent pool. The lower boundary fee assumes that prior information from the patent is available and only up to three patent claims (selected by the owner) are tested; and*
>
> *(3) Approx. >20,000 Euro [>$23,000] per patent for an extensive essentiality and/or infringement test in the context of a court case, including extensive search for technologies that may constitute alternative solutions." (citation omitted)*

Reviewers working on these third-party patent-counting studies typically spend, at most, a few hours per patent, which puts these assessments at the low end of low-cost "Category 1," as defined above. For example, in a patent-counting study Fairfield conducted on LTE, it states that evaluations performed by the panel are preliminary technical assessments, based on an average of one hour of

[15] *Patents and Standards*, Study Commissioned by European Commission's DG Growth (2014), at p. 114.

[16] *Id*. at p. 148 (I converted euros converted into U.S. dollars at the exchange rate prevailing at the publication of the report DG Growth commissioned, approximately 1.14 dollars-to-euro).

analysis per patent.[17] As seen in the excerpt below from the patent study conducted by Fairfield, the study authors note the difference between their essentiality checks and what is entailed in determining patent value in its 2010 patent essentiality study report on LTE:[18]

> *It is also important to address the status of the essentiality data. In practice, the value of a patent depends on several legal and commercial factors. By contrast, the evaluations performed by the panel in this study are preliminary technical assessments, based on an average of one hour of analysis per patent. Determining the scope of a patent and its commercial value, if any, requires several days of effort by lawyers and engineers, and sometimes weeks or months of adjudication by judges and juries.*

To put this in perspective, to complete even a cursory analysis, the analyst must actually read the patent in question and compare it to the sophisticated and detailed standard. An hour is insufficient time to the job properly for the purposes of portfolio valuation for licensing purposes. Even if the kind of information resources that are typically used for in-depth patent evaluations were at hand, including patent claim charts and patent prosecution file histories, which are typically not considered in these patent-counting studies, it would take far longer than an hour or so to review these or the technical specifications in the standards that can each run to hundreds of pages.

Further, the extent to which increased accuracy and reliability might come from spending more time and money on these third-party assessments is untested and, therefore, unproven empirically. In any event, it typically would be uneconomic for publishers of these cited studies to spend even as much as is required in "Category 2" (let alone "Category 3" levels) for a large proportion of declared-essential patents. For example, the third-party studies analysed over 1,000 declared patents to determine a given company's share of the overall standard. Assuming a cost of $10,000 per patent (the low-mid-point cost of the "Category 2" review), a review of 1,000 patents would cost $10 million. A review of 1,000 patent families would cost even more. The CRA report estimates that performing a "mid-level" essentiality test on all 47,500 2G, 3G and 4G SEPs would cost $475 million.

Patent-counting studies are highly subjective and inconsistent with each other

If, to take an absurd example, essentiality is determined randomly by a coin toss – heads for essential and tails for non-essential – two different coin-tossing assessors evaluating the same stack of patents can be expected to agree with each other in 50 percent of their determinations. In my experience, they do not do much better than that.

Given the weaknesses in patent counting that I have already discussed, it is unsurprising that the patent-counting studies that I have analysed produced wildly divergent results. Assessing essentiality of many patents, and comparing essentiality assessments across patent owners, is simply too costly and burdensome to carry within the time and cost constraints of a typical study performed by a third-party research firm.

Different assessors come up with wildly different results because determinations involve a

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[17] *See* Fairfield Resources, *Review of Patents Declared as Essential to LTE and SAE (4G Wireless Standards) Through June 30, 2009* (Jan. 2010), (page 17).

[18] *Id.*

significant amount of inherent subjectivity, inaccuracy and is subject to unintentional and intentional bias. For instance, LG's share of judged-essential LTE patents range from 2.9 percent by Fairfield to 23 percent by Jefferies. Thus, the two patent-counting studies' estimates differ by a factor of eight. Huawei's share of judged-essential LTE patents range from 0.6 percent by Jeffferies and 1.0 percent by Fairfield to 9.0 percent by Cyber Creative and 10 percent by ABI. Thus, patent-counting studies' estimates for Huawei differ by a factor of seventeen. Nokia's share of judged-essential LTE patents range from 2.3 percent by iRunway to 54 percent by Fairfield. Thus, patent-counting studies' estimates for Nokia differ by a factor of 23. These wide ranges are not exceptions, they are quite typical among results for patent owners across all the studies. They reveal major shortcomings in patent counting and suggests that the accuracy and reliability of patent counting and any implied measurements of relative patent strength among different SEP portfolios is doubtful.

In 2011, I published a paper describing my comparison of the results of two different patent-counting studies (Fairfield (Study A) and Jefferies (Study B)) and my efforts to determine whether the two studies agreed regarding how many LTE standard essential patents were owned by different companies active in the telecommunications industry.[19]

Specifically, as described in the paper, I statistically evaluated the results of Study A and Study B and published my findings in the IP Finance blog and in the RCR Wireless trade publication in 2011. I ran a linear regression between the results of the two studies (i.e. the number of patents or patent families found essential for each patent owner). My linear regression tested whether the results of the two studies might agree.

From the regression, I derived an r^2 coefficient, which measured the proportion of variation between the two variables corresponding to the results of the two patent-counting studies.[20] The r^2 coefficient is a conservative measure of agreement because it reflects an effective maximum amount of agreement between two studies.[21] That is, the extent of agreement between studies and patent-essentiality or patent-strength measurement accuracy is no better than, but might be worse than, that indicated by the r^2 coefficient.

An r^2 coefficient can range from 0 to 1, with a score of zero meaning that there is no correlation between the variables and a score of one meaning that the two variables are perfectly correlated. Because both Study A and Study B attempted to measure the same thing (the proportion of total patented essentiality each company possesses in LTE), one would expect the r^2 coefficient to be very close to 1 *if the studies are accurate and reliable measurement tools*.

My analysis, however, established that the r^2 coefficient of Study A compared with Study B was 0.0008. This is extremely, and remarkably close to zero, and indicates that Study A and Study B were almost totally uncorrelated in their results.

Notably, in the absence of additional checks, an r^2 coefficient alone does not reliably confirm

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[19] K. Mallinson, Valuing IP in Smartphones and LTE, IP Finance (Nov. 7, 2011). A version of this article was published in RCR Wireless (a wireless trade publication). K. Mallinson, No Consensus on Which Patents are Essential to LTE, RCR Wireless (Nov. 16, 2011).

[20] The r^2 coefficient is a "dimensionless" quantity; that means it is independent of the units of measurement of the two variables.

[21] This kind of regression analysis has been used for decades to compare and even calibrate measurements techniques in medical electronics including those for bone density and blood oxygenation. These applications of the technique which are seeking to show agreement are much more exacting than merely using it to show disagreement between two assessments, as I do between pairs of essentiality studies.

agreement, nor does it reliably confirm that either set of results are accurate. A high r^2 coefficient is suggestive of close agreement, but there are other reasons why the two studies may disagree even with a high r^2 coefficient. It is theoretically possible for there to be a high r^2 coefficient and for two studies to be in close agreement (e.g. because they were undertaken by the same subcontractor using identical analysis in both studies) while the studies are, nevertheless, both inaccurate. It is also possible for regression results to have a high r^2 coefficient where study results have significant disagreement due to an offset or bias (e.g. revealed by a non-zero intercept on the regression line). There is also the theoretical possibility that the r^2 coefficient could be 1 with a perfect negative correlation: however, any negative correlation would be perverse in this context comparing results of patent-counting studies where the expectation is that the different studies will be positively correlated and the test is to measure the extent to which there is variation from perfect positive correlation, indicating some disagreement between the two studies. Any negative correlation would mean that there would be an inverse relationship between the rankings of SEP owners in one study versus the other. This would also indicate major disagreement between the studies and measurement inaccuracy in at least one of the two studies compared.

Nonetheless, for purposes of my analysis, the r^2 coefficient is a useful measure because it is a conservative way to test agreement between the studies. Studies may agree *less* than what the r^2 coefficient suggests, but they will not agree *more*. Further, I was not testing to affirm agreement between studies or to affirm measurement accuracy. Instead, my test conservatively measured (i.e. understated) disagreement between the two studies. Employing a simple analogy, we could use two different tape measures to measure many tables of differing lengths between 3 feet and 15 feet. Because different tape measures are supposed to be producing the same results (i.e. accurate length measurements, even if one tape measures in millimetres and the other in eighths of an inch) one would expect the r^2 coefficient to be very close to 1 in linear regression of all the measurements pairs. However, if, for example, one tape measure was defective (e.g. very stretched in certain places along its length), then statistical analysis might produce an r^2 coefficient significantly less than one.

My 2011 paper has been cited several times. A study commissioned by the European Commission's DG Grow program cited my work in a 2014 report on standard essential patents.[22]

I used the same methodology I employed in my 2011 paper to systematically analyse all the various LTE patent-counting studies identified above.

The parties who undertook these various patent-counting studies employed varying levels of essentiality and other analysis. For example, while Fairfield claims to do no more than make preliminary evaluations on essentiality, Article One claims also to assess whether patents are "highly essential and highly novel" and iRunway claims to make its assessments, including whether patents are "seminal" with use of "22 parameters including infringement detectability and dependent claims, technology activity rate, backward and forward references, age of patent etc." I compared the results of each patent-counting study against the results of every other study and tested to see if there was correlation between the results of every pair of studies. I found that the results of the patent-counting studies were wholly inconsistent, but with one clear exception. Results among the three CyberCreative studies were somewhat similar because they were all largely the same study, revised annually with additional patents included and some methodological change.

For each pair of studies, I ran a linear regression on the patent counts for each individual patent owner cited in the study. I then analysed the associated r^2 coefficient generated by the same statistical analysis program (a standard capability included in recent versions of Microsoft Excel) to

[22] at p. 116.

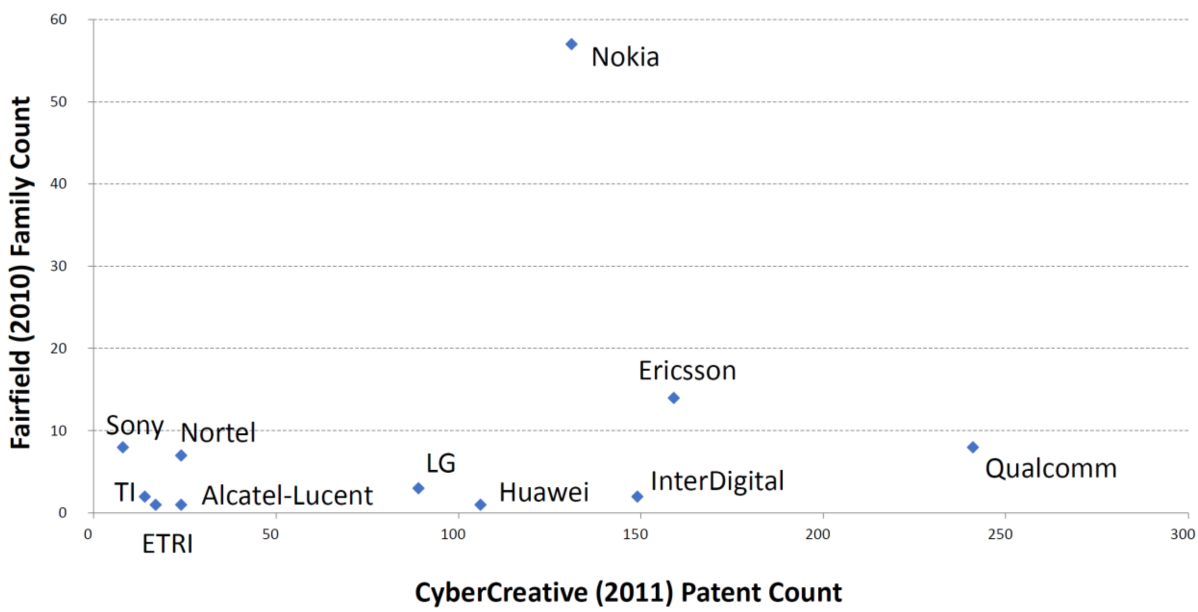
determine the extent to which the results of one study correlated with those of the second study in each pair. For example, I analysed an essentiality study conducted by CyberCreative in 2011 against an essentiality study conducted by Fairfield Resources International published in 2010. Both studies purported to count the number of LTE standard essential patents or patent families owned by several companies active in the telecommunications industry:

Figure 4: Comparing Results of CyberCreative (2011) Against Fairfield (2010)

COMPANY	CyberCreative (2011) Results (Patent Count)	Fairfield (2010) Results (Family Count)
Qualcomm	241	8
Ericsson	159	14
InterDigital	149	2
Nokia Corp	131	57
Huawei	106	1
LG	89	3
Alcatel-Lucent	24	1
Nortel	24	7
ETRI	17	1
TI	14	2
Sony	8	8

I then charted the results of one study against another. I excluded companies that were not reported in both studies:

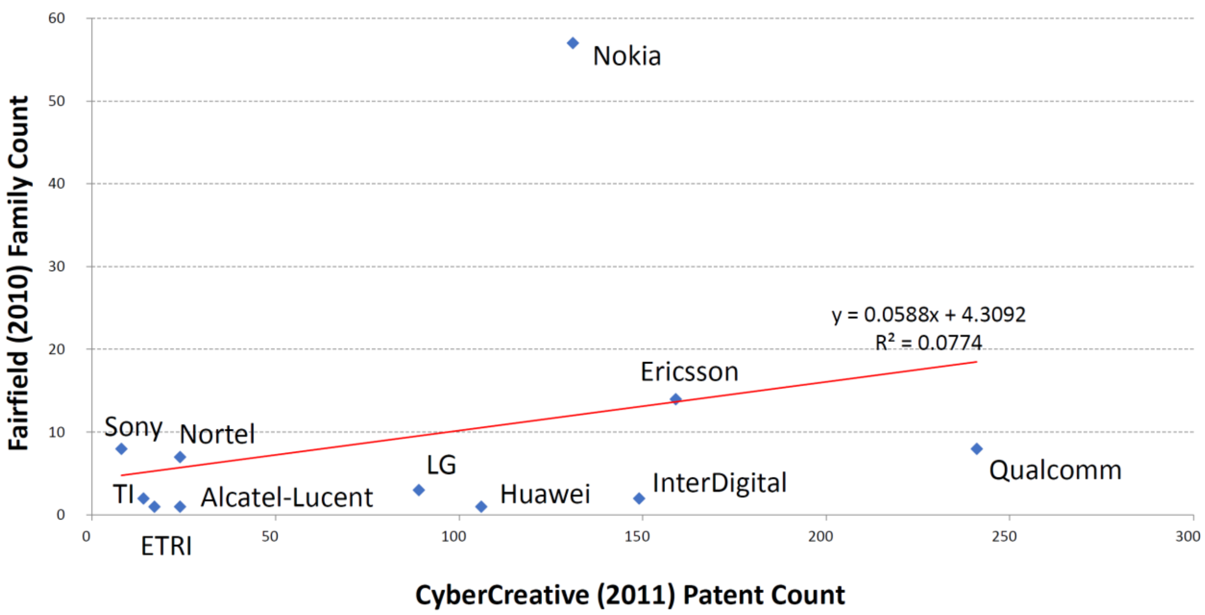
Figure 5: Charting Results of CyberCreative (2011) Against Fairfield (2010)



After charting the results, I ran a simple linear regression between the results of the two studies. The statistical program I used to run the regression also reported the corresponding r^2 coefficient. If the linear regression had yielded a result with an r^2 coefficient close to 1, then the CyberCreative and the Fairfield studies would have had a very strong correlation which means the studies might be in close agreement with each other. Instead, the linear regression yielded a result with an r^2 coefficient of only 0.0774, which is quite close to $r^2=0$ that corresponds to no correlation whatsoever. The CyberCreative and the Fairfield study results, therefore, have only a weak correlation with each other and it can be reliably concluded that there is major disagreement between the results of these two studies.

I have charted the linear regression line and the formula in Figure 6:

Figure 6: CyberCreative (2011) vs. Fairfield (2010) With Linear Regression Line



I repeated this same analysis on every pair of LTE patent-counting studies. I ran linear regression comparing each of the various LTE patent-counting studies against all other LTE patent-counting studies I have identified. For example, Figures 7 and 8 compare the results of CyberCreative (2012) study with those for Article One Partners (2012) in the same way as above.

Figure 7: Comparing Results of CyberCreative (2012) With Article One (2012)

COMPANY	CyberCreative (2012) (Patent Count)	ArticleOne (2012) (Share of A-rated Patents)
ZTE	311	4.5%
Qualcomm	297	14.4%
Samsung	297	9.9%
Nokia Corp	273	13.7%
Huawei	257	5.8%
NTT DOCOMO	206	6.0%
LG	196	9.5%
InterDigital	193	8.1%
Ericsson	180	8.0%
Motorola	101	4.2%

Figure 8: Regression Results of CyberCreative (2012) With Article One (2012)

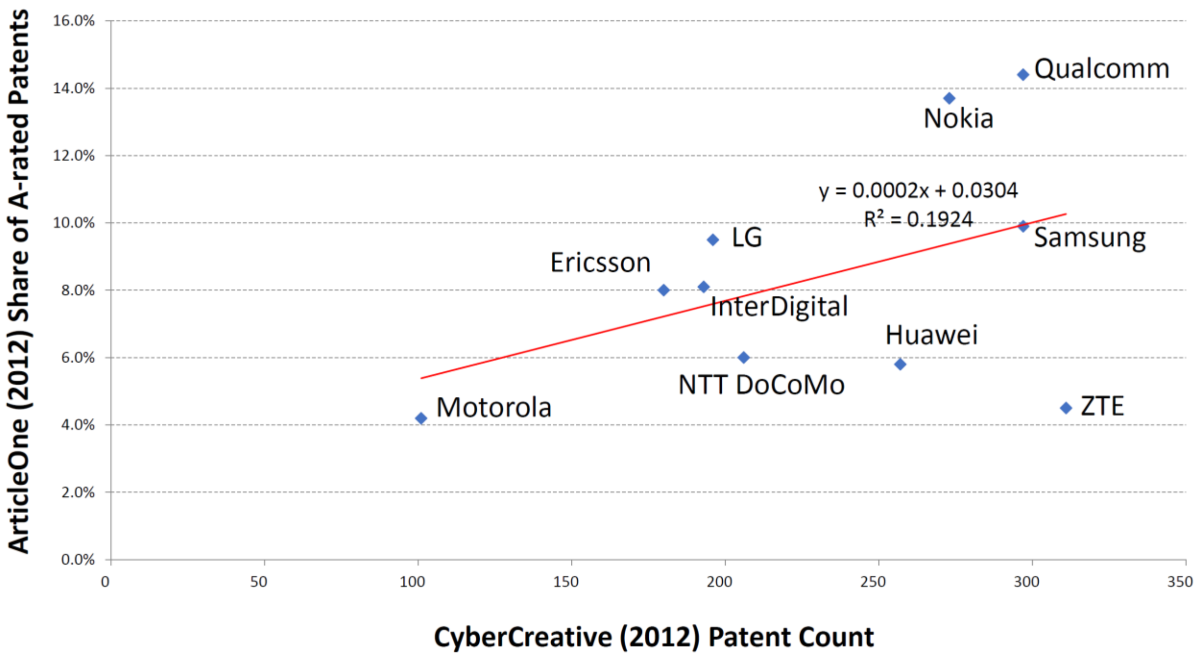


Figure 9 is a matrix and heat map showing generally weak correlation among patent-counting studies by reporting the r^2 values of each comparative linear regression:

Figure 9: R^2 Results in Comparing Different Essentiality Studies

	Cyber 1 (2011)	Cyber 2 (2012)	Cyber 3 (2013)	Article One (2012)	Jefferies (2011)	iRunway (2012)	Fairfield (2010)	ABI Research (2009)
Cyber 1	1.000	0.868	0.817	0.137	0.285	0.654	0.077	0.666
Cyber 2		1.000	0.947	0.192	0.276	0.677	0.170	0.541
Cyber 3			1.000	0.309	0.340	0.577	0.081	0.628
Article One				1.000	0.287	0.253	0.343	0.350
Jefferies					1.000	0.305	0.001	0.407
iRunway						1.000	0.004	0.387
Fairfield							1.000	0.004
ABI Research								1.000

Color	Range
Blue	1.00
Green	0.75 – 0.99
Yellow	0.50 – 0.74
Orange	0.25 – 0.49
Red	0.00 – 0.24

The generally low r^2 coefficients show major differences in results among all studies from different assessors. Correlation among the results of the different studies is generally rather weak, as indicated by r^2 coefficient results averaging 0.285. In this average figure, I exclude correlations among Cyber Creative studies, which are evidently substantially the same study. Only the r^2 coefficients for regressions between the Cyber 3 study and other assessors' studies are included in this average figure. Even where the r^2 coefficients are significantly above this figure with regressions between some pairs of studies, there are major differences between other related regressions.

The widely different results shown in Figure 5 are the result of differences in how the studies have been conducted, as well as the significant variations in specific assessments of the companies being studied. For example, some studies only consider companies that rank highly in counts of declared patents. This leaves a large "other" category of declared patents that are not further assessed. Many companies that make it to the named rankings in some studies are not named in other studies. The differences in rankings, and whether a company appears at all in the rankings, also depends, in large part, on whether the subjective assessment in question is only for essentiality, or if it is also based on a subjective assessment of whether SEPs are "seminal," or "highly essential and highly novel," as well as competence and bias on the part of the reviewers.

Given the major inconsistencies among the patent-counting studies identified, the highly subjective nature of the technical review component of these analyses and the generally low r^2 coefficients, one cannot rely on the results of any one study with confidence. The subjective nature and many major differences among these studies further suggest that the results of a patent-counting analysis are subject to manipulation.

Where correlations between pairs of study results are significantly higher than average, it might be to some extent by chance, or because there is some relationship between the results of the studies. The individuals or companies tasked with the technical analysis might be significantly swayed by results of previous studies or there might be more direct commonalities. The identity of these individuals or companies is not always clear. For example, the Article One Partners report states that "the data analysis set forth herein was prepared by a third-party data provider and is believed to be reliable, but has not been independently verified by AOP."[23] It may be impossible to establish if some of the same individuals or companies are contributing to more than one study. Nevertheless, my overall regression results confirm an overall low level of commonality in results among different patent-counting studies.

The most prominent exceptions among these weak or moderate correlations are for the regressions among the three Cyber studies. These study results are relatively closely correlated, as indicated by r^2 coefficient values from 0.817 to 0.947, which are the highest in my regression analysis. This is unremarkable and does not invalidate or diminish my conclusion about disparities among different assessors. To the contrary, close correlation is to be expected among the results of these three studies. The three Cyber studies are similar with respect to methodology and data, and with additional patents and assessments added to the second and third versions of the study.[24]

The close correlation among Cyber study results over three years helps in the consideration of the extent to which timing differences in the studies contribute to the weak correlations. One might hypothesize that much of the differences between results of studies conducted in different years is because companies' positions with respect to SEP ownership might have shifted significantly from year to year. However, the relatively close correlation of Cyber study results suggests that timing, with additional patents included in the later studies, is not the most significant reason for the discrepancies between the results with the other patent-counting studies.

No short cut through random sampling

The CRA report proposes that only relatively small samples of patents from each owner's portfolios need be assessed; with time and money available allocated in a more focused manner so that each patent sampled is assessed in depth. This is not a viable alternative.

One of the reasons the third-party patent counting studies I have analysed are so inaccurate is because they spend so little time and money per patent. The CRA report indicates that it would cost a prohibitively high $10,000 per patent and $475 million in total to perform a "mid-level" essentiality test on all patents declared to ETSI in relation to the 2G, 3G and 4G standards. One would expect this rather more extensive evaluation – typically including review of claim charts and prosecution histories – to be more accurate and reliable than the studies I have analysed. However, the extent to which that expectation might be true is untested. Therefore, it cannot be assumed that such analysis would be significantly or sufficiently better than the very inconsistent studies I have analysed above, even on a patent-by-patent basis.

The ability to save cost through random sampling is also significantly limited due to uncertainties

[23] Article One Partners, LTE Standard Essential Patents Now and in the Future (2012).

[24] Cyber Creative Institute Co. Ltd., Evaluation of LTE essential patents declared to ETSI, (June 2013) at p. 2.

and inaccuracies in determinations. The CRA report also states incorrectly that standard-essentiality for an entire portfolio can be assessed with as little as two percent of the SEPs:

> *"Still, there is one additional issue to consider in a random testing environment: we have to ask how intensive the sampling of portfolios needs to be to provide us with a reliable estimated. There is a rigorous statistical answer to that question. Either a patent is essential, or it is not. Denote the proportion of essential patents in a portfolio of K patents by α. How many of the K patents do we need to test so that the proportion of patents found essential, defined as β is likely to be close enough to β? Suppose for example that we test 30 patents and find that 30% of them are essential. Using the "normal approximation" approach to the distribution of a binomial sample mean, we would get that there is a 95% chance that the actual proportion of truly essential patents in the whole portfolio is between 27% and 33%. This is quite a good precision so that the method would not expose patent-holders to any considerable risk of error.*

The above analysis is simplistic and incorrect because it ignores the imprecision in determining portfolio essentiality. Small sample sizes could only provide such a high confidence interval if essentiality could be determined with the predictability of a coin toss. This is not possible with all the heterogeneity across patent portfolios, with all the uncertainties and skews in patent selection (e.g. relating to device claims rather than network equipment claims and in selecting patents from patent families) and in individual essentiality determinations. Similarly, consider the inaccuracies among voting surveys in their attempts to predict the recent binary outcomes of the Brexit referendum and US Presidential election. Voters simply had to vote "in" or "out" in the former and for Donald or for Hillary in the latter, and yet surveying those was far from clear cut with biases in methodologies, uncertainties in accuracy of responses and with continuous change in voting intentions. Despite sample sizes in the thousands, there were discrepancies of many percent among survey results and the actual poll outcomes. The smaller the sample size, the more any determination errors will be magnified in estimating company shares of total SEPs.

The inapplicability of sampling to determine portfolio patent strength and patent value is even more severe. Consensus is that some patents are worth a lot more than the average patent in a portfolio. However, it is very difficult to identify which patents are particularly valuable and exactly how much more than average they are worth. The example of C*SIRO v. Cisco*, with one patent licensing at approximately one dollar or more per unit in comparison to very little paid for most WiFi patents, some patents are worth hundreds of times more than the average SEP in a standard. That patent was either unique or there are a very low number of such high-value WiFi patents. Sampling patents to determine portfolio value in these circumstances would be as inaccurate and unreliable as taking any size sample of straw less than the entire haystack to estimate the number of needles in there.

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