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Abstract. An essential patent or standard-essential patent (SEP) is a patent that claims an invention used to comply with a technical standard. The patent policy of the standards setting organization specifies a condition called FRAND as licensing terms and conditions for SEP. However, it has been difficult for companies that adopt standards to grasp the total royalties, because the specific royalties of FRAND are usually not defined in the patent policy of the standards setting organization. The potential royalties payment may thus represent an intellectual property risk to those companies that implement technology subject to standardization. In this paper, we derive a formula for calculating the intellectual property risk of the implementer of SEP by modeling SEP holders. In addition, the IPR risk of IEEE 802.11 is calculated and the result of the calculation is validated. Disclaimer. While the present paper has been prepared with HCC14, The authors are not liable for any direct, indirect, special or consequential losses or damage of any kind, or loss of profit, derived from using any of the information contained in the present paper.

Keywords: Patent, Technical Standard, SEP, Royalty, FRAND.

1 Introduction

An essential patent or standard-essential patent (SEP) is a patent that claims an invention used to conform to a technical standard. Many standards setting organization (SSO) have established a patent policy that deals with the SEP when developing standards. If a member of an SSO considers that it owns a SEP, that member is required to declare its intention to grant a license free of charge or under reasonable and non-discriminatory (FRAND) conditions in other words, such a (FRAND) declaration implies that the SSO member is ready to allow other parties to use its invention, if those other parties implement the standard technology and comply with certain conditions. The details of the patent policy are different depending on each SSO. While many if not all refer to FRAND terms and conditions, none of them specifies the amount of the license fees. Usually, SSOs also do not determine whether a standard is covered by the alleged SEP.

After a standard is established, many SEP are licensed in patent pools formed by multiple patent holders [1]. A patent pool is a system where a number of SEP holders concentrate their SEPs and collectively license those rights to third parties and/or to members of the pool. However, some companies do not participate in patent pools but engage in patent licensing activities on their own, by engaging in a number of bilateral negotiations and bilateral licensing programs with other users of the standard [2]. There have been a number of cases where SEP holders outside of the patent pools file infringement lawsuits against companies that sell products conforming standard specifications and demand high royalties. It cannot also be excluded that patent holders have been filed lawsuits following failed negotiations under a patent pool [3-6].

For this reason, it is desirable for companies who incorporate certain standards into their products to identify the total royalties as an IPR risk, which is the sum of royalties of patent pools and royalties that may be paid in the future to companies outside the patent pools. However, it is difficult to grasp the total potential royalties, because it is not clear nor well-established how much the royalty per SEP is, whether all patents should be entitled to the same royalty rate and what the total number of SEP is. One reason lies in the difficulty for SSOs to commit to an amount of royalty rates under FRAND due to regulations under the anti-trust law. In order to calculate the total number of SEP, it is also necessary for experts to determine the essentiality of SEP candidates after screening all candidates including those shown on SSO databases and those that are not recorded in such databases.

2 Research Subject

Since the total royalties payable for SEP is the license fee per SEP multiplied by the total number of SEP, the difficulty of estimating the total royalties may be addressed by separately considering the respective causes of royalty per SEP and the total number of SEP.

First, it is unclear how much the royalty per SEP is. This is because the definition of FRAND in the patent policy of the SSO is not clear nor given. However, if an SSO clarifies the licensing fees of standards, it may raise doubts to violate the anti-trust law. In relation to some standards, the agreement of the major SEP holders on the total royalty for SEP is expressed, as made public by press releases; in some cases, including Microsoft v. Motorola (U.S. District Court, 2013) and TCL v. Ericsson (U.S. District Court, 2017), courts decided the royalty for each essential patent by adopting total royalty announced and the top-down approach. However, many SSOs do not specify such an agreement.

Secondly, it is difficult to calculate the total number of SEP for any standard. The number of SEP owned by patent pool licensors is usually provided by patent pools. The number of SEP owned by a patent holder who has made a FRAND declaration may be calculated from the patent information published in databases of FRAND declarations of SSOs. However, it is not easy to determine the number of other SEP because this requires an expert to evaluate on the essentiality of all possible granted patents.

3 Calculation Hypotheses for Essential Patents

Based on the research subject illustrated in Section 2, in order to utilize this approach for the calculation of IPR risk as a total royalty, we will extract major cases concerning patent policies and FRAND declarations of SSOs and examine the method of calculating the total number of SEP and royalty per patent.

3.1 Example of Trial Calculation of Patent Fees Based on Patent Pools

Microsoft v. Motorola case (U.S. District Court, 2013) is the first trial in the world that assessed the royalties for SEP. In this case, the benchmark was calculated based on the ratio of the number of patents in the patent pool to the number of Motorola's patents that is multiplied by the royalty fee of the patent pool. In this case, the license fee for the patent pool was pointed out to be lower than the average license fee in the market.

3.2 Comparative Approach

In the United States, the Georgia-Pacific factor is known as a criterion to calculate reasonable royalties. In Microsoft v. Motorola case (U.S. District Court, 2013), the application of Georgia-Pacific factor to SEP was considered, and the licenses of the case on a similar background could be referenced, and multiple licenses, including patent pools, were adopted as a benchmark for royalties. In Unwired Planet v. Huawei case (United Kingdom High Court, 2017) comparable licenses were selected and royalty rates were calculated as a relative number ratio of patents. CSIRO v. Cisco case (United States, CAFC, 2015) also adopted a comparative approach for a license fee for SEP. Thus, if the total number of SEP is estimated and a comparative approach is used to the known royalties, such as patent pools, then it is possible to calculate royalties for the total number of SEP.

3.3 Calculating the Total Number of Essential Patents

In calculating the total number of SEP, it is necessary to estimate the number of patents of SEP holders who are involved in standardization but do not participate in patent pools, or who are not involved in standardization. In Dell case (FTC 1996) the standard for personal computer Bus was developed in VESA and Dell's failure to disclose a patent was the issue. In particular, Dell exercised its patent right after VESA Bus became commercially viable. FTC ruled that Dell's actions violated Section 5 of FTC Act. In Rambus case (FTC 2008), FTC charged that the company violated the disclosure requirements of its patents.

Then, cases of violations of the FRAND commitments have subsided, and the duty of good faith as a contract has come to be discussed in the point of view of FRAND in subsequent infringement trials. Therefore, SEP holders are now well aware that if they intentionally evade the FRAND declaration, they would not be permitted to exercise their rights with high chances of success. In other words, no SEP holders seem to evade

the FRAND declaration on purpose. At least, for the purpose is an estimation of the IPR, it would give a little impact on the calculation to exclude SEP holders who evaded the FRAND declaration on purpose. We can therefore summarize the hypothesis regarding the royalty and total number of SEP as follows:

- If a patent pool exists for a standard, the patent pool royalty can be used as the basis for the royalty per patent in calculating the IPR risk.
- The use of the comparison approach allows the calculation of the total license fee for SEP by multiplying the ratio of the number of patents in the patent pool to the number of all SEP by the license fee for the patent pool.
- When totaling the number of SEP for the purpose of estimating the IPR risk, there is little impact on the calculation even if the number of patents of SEP holders who evaded the FRAND declaration on purpose is excluded.

4 SEP Holders Model

4.1 Attribute Information

Prior to tabulating the total number of SEP based on the hypothesis in Chapter 3, the following attributes are extracted for SEP holders, in relation to their activity in the standardization and the patent pools.

- Participation in standardization: Many SEP holders participate in SSO committee. It is difficult to make inventions resulting in SEP without getting in touch with the drafts and discussions in the SSO committees.
- FRAND declarant: Among the participants in SSO committees, SEP holders have made FRAND declarations to comply with the patent policy of SSO.
- Licensor in patent pools: Some of FRAND declarants are licensor in patent pools.
- Licensee in patent pools: Some FRAND declarants are licensee and do not license in patent pools.

4.2 Hypothesis SEP Holders Model

Based on the attribute information above, SEP holders are classified into the following models 1 to 6, when considering the aim of calculating intellectual property risks [7].

1. Pure licensors: Patent holders who participate only as licensor in patent pool.
   Licensors in patent pools are actual SEP holders and are required for calculation.
2. Cross-licensors: Patent holders who participate as Licensors and licensees in patent pool.
   As with pure licensors, they are actual SEP holders and are essential for calculation.
3. Pure licensees: Patent holders who participate only as licensees in patent pool

FRAND declaration was done but the patent might not finally cover the standard. Since their patents are not licensed in patent pool, they are excluded in the calculation.

4. Non-participants in patent pool: Patent holders who have declared FRAND and have not participated in patent pool. This entity may be engaged in patent licensing activities alone and are required for calculation.
5. FRAND non-declarants: Patent holders who participate in standardization committee and have obtained SEP,but have not done FRAND declaration and not have participated in any patent pool. FTC prosecuted those who evaded the obligation of the FRAND declaration on purpose in the past. Now there does not seem to be such SEP holders, and they are excluded from the calculation.
6. Non-participants in standardization: Patent holders not involved in standardization activities. Although there may be researchers who have made basic inventions outside of SSOs, this number is considered to be small in comparison with the number of licensors of patent pools. So they are excluded in calculation.

Therefore, SEP holders model to be considered in calculating IRR risk are 1, 2, and 4.

5 Risk Calculations for Patent Implementers

5.1 Defining Variables

IPR risk is the total royalty that a company must pay to sell a product that incorporates a standard. In deriving the formula for calculating IPR risk, Ri, variables are defined as follows.

Ro_n: fee for patent pool n (Dollars)
P_n: number of patents licensed in patent pool n,
AR: Average royalty in patent pools (Dollars)
NP: Number of patents of non-participants in patent pool (corresponds to Model 4 in the previous section)
Ri: IPR Risk
N: Total number of patent pools
NPk: Number of patents owned by non-participants in patent pool with known number of patents
NPu: Number of patents owned by non-participants in patent pool with unknown number of patents
MNPu: Number of non-participants in patent pool with known number of patents
ANPk: Average number of patents owned by patent holders with known number of patents

5.2 Considering only one pool of patents

Based on the calculation hypothesis and SEP holder classification model and variables presented in the previous sections, IPR risk is calculated with N = 1. Then, IPR risk is

calculated by multiplying the relative ratio between the sum of the number of patents P_1 and the number of patents NP to the number of patents P_1 by the royalty Ro_1.

$$Ri = \mathrm{Ro}_1 \cdot (\mathrm{P}_1 + \mathrm{NP})/\mathrm{P}_1 = \mathrm{Ro}_1 \cdot (1 + \mathrm{NP}/\mathrm{P}_1) \qquad \text{(Eq1)}$$

5.3 Considering multiple patent pools

When there are multiple patent pools (N), the average royalty AR is derived by averaging the royalties of each patent pool with the weigh of the number of patents held (Eq2), Ro_1 of the (Eq1) is replaced by AR, and P_1 of (Eq1) patent pool is replaced by the sum of the number of all N patents P_n, expanding (Eq1) to the formula to calculate Ri that constitutes the IPR risk (Eq3).

$$\mathrm{AR} = \sum_{n=1}^{\mathrm{N}} (\mathrm{Ro}_n \cdot \mathrm{P}_n) / \sum_{n=1}^{\mathrm{N}} \mathrm{P}_n \qquad \text{(Eq2)}$$

$$\mathrm{Ri} = \mathrm{AR} \cdot (\sum_{n=1}^{\mathrm{N}} \mathrm{P}_n + \mathrm{NP}) / \sum_{n=1}^{\mathrm{N}} \mathrm{P}_n = \mathrm{AR} \cdot (1 + \mathrm{NP} / \sum_{n=1}^{\mathrm{N}} \mathrm{P}_n) \qquad \text{(Eq3)}$$

5.4 Estimation of NP when the number of patents held by non-participants in patent pool is unknown

If the patent number is not disclosed in a SSO that permits the "blanket" FRAND declaration, NP cannot be calculated only from the information of the patent number disclosed in the FRAND declaration. In this case, NP are estimated by the sum of the total number of patents NPk of patent holders with known number of patents and the total number of patents NPu of persons with unknown number of patents. Then NPu is estimated by multiplying the average number of patents owned by patent holders with known number of patents ANPk by the number of non-participants in patent pool with known number of patents MNPu. This procedure finally leads to (Eq4):

$$NP = NPk + NPu = NPk + ANPk \cdot MNPu \qquad \text{(Eq4)}$$

6 Standard 802.11 IPR Risk Calculations

6.1 Standards: 802.11

802.11 is an international standard for wireless LAN (Wi-Fi) developed by IEEE, like for instance 802.11b which was the most popular in the early stage, improved then by versions 802.11a, 802.11n, etc. (Hereinafter collectively referred to as 802.11 including the improved versions). Although there are many products on the market, licensing of SEP in patent pools has not been so active, and there is no agreement on the total license fee. The FRAND Declaration Database (LOA) of IEEE discloses SEP patent-number and other information, and the number of patents can be counted. However, some SEP holders have not disclosed the patent-number. Subsidiaries and affiliates will

be counted as a single corporation. The published patents are also calculated in the total number [8].

6.2 Patent Pool – Via Licensing

Via Licensing is a patent pool covering information and communications technology, and licenses 802.11 SEP in its program. The standard rate is $0.55 per unit, which is used as Ro_1 to calculate [9]. Via Licensing doesn't disclose the patent-numbers of 3 licensors, so we estimate such numbers. For NTT we adopt the number of patents disclosed in the FRAND Declaration. For LG we adopt the number of patents that LG license in Sisvel. For ETRI we adopt the number of patents that ETRI has licensed in Sisvel in 2015. As a result, 3 patent holders were found to have licensed 272 patents.

6.3 Patent Pool – Sisvel

Sisvel is a European headquartered patent pool that licenses 802.11 SEP. The patent- is available on their website [10]. The standard rate is €0.3 per unit, so we calculate Ro_2 as $0.34. The transferees of patents shall be regarded as FRAND declared entities, etc., and shall be counted. As a result, 8 parties have licensed P_2=469 patents.

6.4 Calculating IPR Risk

Substituting $P_1 = 272$, $P_2 = 469$, $Ro_1 = 0.55$, and $Ro_2 = 0.34$ into (Eq2) yields an average royalty rate AR=$0.41. To Fix NP of (Eq4), one candidate of ANPk is the average number of Sisvel licensors 59 and one other candidate is the average number of non-participants in patent pool who disclose their patent-numbers as being 14. Because there is a wide gap between the two candidates, both shall be adopted as the upper and lower bounds of the range, and IPR risk shall be calculated as the range. Then, substituting ANPk = 14 ~ 59, NPk = 470, and MNPu = 55 into (Eq4), NP = 1240 ~ 3715.

Consequently, NP = 1240 ~ 3715, AR = 0.41, $P_1 = 272$, and $P_2 = 469$ are substituted for (Expr3) to derive IPR risk Ri . However LG's patents are overlapping in the two patent pools, so the sum of P1and P2 shall be reduced by the number of LG patents 131. As a result, Ri is estimated as $1.26 ~ 2.96.

7 Validation

7.1 Validation approach

The IPR risk of 802.11 patent licensees $1.26 ~ 2.96 calculated in the previous chapter is validated by information such as royalties in actual cases that have not been referenced in the calculation step. VRo is defined as the royalty per SEP in the case, VPt is the expected total number of SEP, and VRi is defined as IPR risk for validation. By multiplying VRo by VPt to derive VRi (Eq5), the range of the IPR risk for validation

VRi for 802.11 is determined from multiple cases and the calculated IPR risk is validated.

VRi: Validation IPR Risk
VRo: royalties per SEP in a case
VPt: Expected total number of SEP

$$VRi = VRo \cdot VPt \qquad \text{(Eq5)}$$

7.2 Expected Number of 802.11 Essential Patents

There is no authorized or official estimation of the total number of 802.11 SEP. In re Innovatio (U.S. District Court, 2013) it was examined the reports from plaintiffs and concluded that there were approximately 3000 patents. The accuracy of this numerical value is not high; however, it is enough to use for the purpose of the validation. So VPt is determined as 3000.

7.3 Example of Calculation of License Fee in Actual Cases

Microsoft v. Motorola (U.S. District Court, 2014) held Motorola's royalties of 802.11 SEP for 11 patents to be 0.8 cents ($0.008), which leads to $0.00072 per patent. In re Innovatio (U.S. District Court, 2013) held the license fee for Innovatio's SEP to be 9.565 cents ($0.0956) for 19 patents. This leads to $0.005 per patent. Thus, $0.00072 and $0.005 are adopted as the lower and upper limits of the range of royalty per patent VRo.

7.4 Validation

VPt and VRo derived in the previous section are input into (Eq5) and the range of the IPR risk VRi for validation comes to be $2.16 ~ 15.0. Comparing the $1.26 ~ 2.96 of Ri from (Eq3) with the $2.16 ~ 15.0 of VRi range, then the matched range is only $2.16 ~ 2.96.

One of the reasons for the difference is that the patent pool fees used, as the basis for calculation is lower than market rates generally. This is confirmed in Microsoft v. Motorola (U.S. District Court, 2014). On the other hand, only 2 cases were used in the validation, so the validity of the range of validation would not be statistically sufficient. We conclude that the risk of intellectual property under Standard 802.11 is $2.16 ~ 2.96 per unit, and we consider the reliability of the formulation of validation to be a future issue, including validation by other judicial examples.

8 Closing comments

The IPR risk calculation of the implementer of SEP is derived. We also calculated 802.11 IPR risk (Eq3) and validated it by (Eq5) to find that the matched range is $2.16 ~ 2.96 per unit. The reliability of the formulation of the validation is a future problem, because calculated range does not always match to the range of the validation. We would like to express our gratitude to Akihiko Ohwada, Takeshi Misawa, Hideo Koike, and others of the Next-Generation Patent Platform Study Group for their discussion.

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