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On Technology Choice in Standardization: Implications for Patent Valuation

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Abstract
The valuation of patents included in standards and their reasonable license fees is affected by two competing views about how and why standards are developed. One view, which emphasizes that standardization is foremost about choosing *a* technical solution, assumes the availability of roughly equivalent alternatives; the other emphasizes that standardization is foremost about picking *the best* technical solution, assuming distinctly different alternatives. These views affect patent valuations but often remain implicit in economic and legal studies.This paper examines which view is more accurate from the perspective of standardizers using data from expert interviews and literature study.

While the study suggests that the availability of roughly equivalent alternatives is generally more accurate, neither view well-captures the reality of standard development. Typically, the relative technical merit of competing solutions is an important selection criterion, but it is secondary to other critical factors. The findings highlight the interrelatedness of the manytechnical design choices usually at stake; the negotiability of and trade-offs between multiple performance criteria determining the value of technical solutions; the filtering effect of consensus versus voting committees on actual technology choice; and, not least, the influence of non-technical factors on technology choice.

Given these caveats, valuating patents-in-standards on their technical, innovative merit will remain contentious. To better account for the influence of the dynamics of standards processes on technology choice, a valuator's line of reasoning should address, among other factors, existing alternative technical solutions and multiple performance dimensions. Follow-up research is recommended that examines the implications of patent inclusion for these dynamics.

Keywords
standardizers, patents, innovation, reasonable royalties, patent valuation

1. Introduction

At a dinner with academics and practicing lawyers in advance of a seminar on the inclusion of patented technology in standards, a debate took place about the nature of standards-focused innovation: Does standardization more often concern left-hand-side vs. right-hand-side-of-the-road type of decisions with regard to the technologies considered, or do standards developers more often face choices between significantly different (i.e. more or less) innovative technologies?[1] As will be explained in the next section, the topic is highly relevant for determining the value of patented technologies included in standards and the height of licensing fees, and therefore for high profile patent litigation that has taken place from the 2000s onward. This paper attempts to feed the debate with insights from experienced standards practitioners and earlier studies in this area (more on methodology in section 3).

The structure of the paper is as follows. First, background information is provided that helps to understand what was at stake during the dinner debate (section 2). Next, the debated question and the research approach are further specified (section 3). The findings are presented in section 4. The paper closes with a conclusion section. Therein the dinner debate is revisited and implications are drawn for the valuation of patents.

Before continuing, let me define two key terms. In innovation research, the term 'innovation' typically refers to products, processes, etc. of which the functionality is new to the market; the price-performance

[1] Personal communication Brad Biddle (Lewis & Clark Law School); confirmed by Stuart Pixley (Microsoft).

ratio is significantly better than that of contemporary products, services etc.; and/ or they are based on new technical or other principles [1]. In the context of standardization research, innovation more commonly emphasizes technical novelty. A patent is "a document, issued, upon application, by a government office (…), which describes an invention and creates a legal situation in which the patented invention can normally only be exploited (manufactured, used, sold, imported) with the authorization of the owner of the patent. 'Invention' means a solution to a specific problem in the field of technology (…). The protection conferred by the patent is limited in time (generally 20 years)" [2, art. 2.1, p.17]. The term 'standard' is addressed separately later on. Relevant at this point is that the paper focuses on committee standardization - and not on *de facto* standardization.

2. Background of Patent Litigation: SEPs, FRAND and Valuation

In information and communication technologies (ICT), where interoperability between products and services is a key issue, patented technologies have increasingly entered standardization negotiations and become part of standards. Some patent owners offer their technology Royalty Free (RF), that is, no licensing fees are asked from standards users. These RF patents pose few problems. Other patent holders, however, have a business model based on deriving revenues[2] from their patented technologies. For them, incoming royalties are a reward for earlier investments in Research and Development (R&D) –or, a means to seek rent for purchased patents(e.g. in the case of Non-Practicing Entities, NPEs, who do not themselves intend to use their patents). In, for example, mobile telecommunication standards, hundreds if not thousands of patents can be involved [4] and their number is increasing [5, 6].

This poses problems for standards developers and standards users. Regarding standards development, the private character of patents and the public nature of standards mix badly [7, p.1]. The inclusion of fee-bearing patents changes the dynamics of standardization. It introduces a new set of stakes and draws to the negotiation table patent-centric [20, p. 206] players with few ties to other market players (NPEs). These are often solely driven by (short term) individual gains rather than (longer term) gains of opening up new markets. They set little store on achieving the best possible collective outcome[3]. As a result, the impact of legal patent issues on standardization has been rising as has. The threat of legal action affects negotiations [4]. It puts pressure on, and introduces extra reasons for strategic caution in, standards processes. Patents add a layer of complexity to 'coordination by committees' [8].

In the 2000s, there was a (second) surge of standards-related patent litigation in the wireless, smartphone and tablet computer industries [9]. At the time, many standards bodies and consortia already had policies for licensing patents on Fair, Reasonable and Non-Discriminatory (FRAND) terms. However, these policies did little to prevent breaches of FRAND licensing terms ex post (i.e., once the standards has been accepted). They did/could/would not clarify whether demanded licensing fees were unreasonably high. Nor could Standards Setting Organization (SSO) rules on patent disclosure prevent what lawyers call 'patent ambush'[4] and economists 'patent hold-up' [10] by 'patent trolls' [11][5],or 'opportunism' (e.g. submitting marginal patents as Standard Essential Patents (SEPs)). Subsequent review of the efficacy of SSO FRAND policies [12, 13] have since led to, for instance, more detailed procedures on licensing commitments and requirements for (timely) patent disclosure [e.g. 14].

Apart from drawing attention to FRAND policies, the lawsuits highlight the difficulty of determining the value of a standardized patented technology where licensing fees are deemed too high (valuation [15, 16, 17, 7]). There is no easy means to distinguish ex post essential patents from marginal ones since even marginal patents, once part of a standard, become essential for standards implementations [18]. Moreover, inclusion of a certain technology in a standard by definition eliminates alternatives and gives the patent holder additional market power [16]. Different studies have been carried out on how best to

[2] Or, e.g. access to competitors' technology in return for technology use.

[3] The significance of these 'game-changers' is elaborated in a forthcoming article.

[4] That is, when a member of a standards committee fails to disclose ownership of a patent relevant to the standard process, and later asserts that the patent is infringed by users of the standard. [7, p.90]

[5] A derogative term for NPEs acquiringownership of patents without the intention of using them to produce products. Rather, they demand payment from companies who – sometimes inadvertently - infringe on their patents. [11]

capture the intrinsic value of a patent ex ante, that is, its value prior to inclusion in a standard [19] to arrive at reasonable licensing fees.[6] This is especially difficult where different market players value technologies on different dimensions [16], a point addressed elaborately later on in this paper.[17, pp. 36-37], however, question the notion of a patent's intrinsic value and argue for different royalties in depending on context and application.

Lastly, several studies focus on the best royalty base from which to calculate FRAND licensing fees [15], such as the price of producing the 'smallest saleable patent-practicing unit', and their underlying logic (i.e., production-or technology-oriented [21]). Moreover, there is concern that the high number of patents in many ICT standards may lead to royalty stacking and excessive cumulative licensing fees for users [4].[7] Holders of essential patents, on the other hand, who may participate in patent pools to ease technology licensing with standards users, face another valuation problem: how to fairly allocate licensing fees within a pool among holders of more or less essential patents. Again, determining the value of patents is a cumbersome and expensive matter.

The disputes and studies sketched above have likely coloured the dinner debate that occasioned this paper (see introduction): two people attending the dinner have advised in the past on related issues in SEP lawsuits.

3. Methodology

While most of studies on SEPs have been written from an economic or legal perspective, this paper is written from a standardization perspective. It examines standardizers' perceptions of, first, technology choice in committee standardization and, second, the nature of standardization. It ends by discussing implications for patent valuation. How are these related? The premise of an ex ante SEP is that a desired standard's functionality cannot be realized without infringing on the patent. The patent's inclusion is therefore unavoidable. SEPs therefore imply reduced technology choice. For if choice were to exist, where possible, royalty-free alternatives would have been chosen or developed (design-around alternatives [4, p. 2039]), reducing the value of fee-bearing patented solutions.

The question of technology choice is intricately tied up with what is viewed as the nature and aim of committee standardization (section 4.4). Extrapolating is about choosing the 'best' technology (innovation angle) or about arriving at a common agreement, irrespective of the technology chosen (market coordination angle)? In the first situation, the technical merit of contributions matters; in the second, choosing itself is key (left-hand-side vs. right-hand-side-of-the-road type of decisions).

For this study, the primary source for understanding what happens in standards committees are experienced standardizers from different SSOs (standards consortia and/or formal standards bodies). Thirteen standardization experts with diverse backgrounds[8] and expertise have been consulted and interviewed. In the text their comments are numbered [i1-i13]. To allow the author to zoom in on their different area of expertise, an open interview technique has been followed, however, always starting with and/or coming back to the same research question: Is committee standardization most often a matter of selecting the *better* technology among alternatives or selecting a technology? Their insights have been complemented by those from the literature (i.e., standardization policy documents, writings from practitioners, and academic economic, innovation, standardization and law-oriented articles and books).[9] Standardization of H.265 / HEVC [29] is used in the following section as a running example.

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[6] Ex ante licensing disclosure and price commitments prior to standard selection have been debated [19] and adopted as policy by two U.S.-based standards developing organizations (VITA and IEEE). [20]

[7] While the problem posed by royalty stacking is under debate [22], interviewees recognize it [i1, i5] and act upon it [i2].

[8] They include people who own patents, working for companies owning patents, are professionally involved with company patents, have been active on Intellectual Property Right (IPR) policy, and/or are open source community members; and from small IT and consultancy companies to multinationals. The interviewees are listed in the reference section; one of them wishes to remain anonymous. They were informed upfront that this study was made possible by a research grant from Intel with assurance of full academic freedom. Two legal practitioners attending the dinner debate and involved in active litigation did not feel free to talk and declined the invitation for an interview.

[9] To better understand the issues at stake, the author listened to taped Youtube lectures by David Teece (2012) and David K. Levine (2015), to an Oxfirst webinar by Robin Jacobs (2016), and visited conference presentations at 'Competition, Standardization and Innovation' (Tilburg University, TILEC, Amsterdam, the Netherlands, December 10-11, 2015) and 'Regulating Patent "Hold-Up"?

4. Technology Choice

Relevant to keep in mind is that, committee standardization is a voluntary activity. Not all parties with knowledge and solutions relevant to the scope of a standards committee will have an interest in participating. Certain technical solutions – whether better or not - may therefore not be available to the standards committee [i4].

Exceptions aside, standards committees seldom start from scratch [i3] or base their work on a single proposal [i8].That is, choosing among and negotiating about multiple solutions is a realistic portrayal of committee work [i1-i13]. In practice, therefore, 'best technology' means best relative to other proposals and emerging solutions. A typical standards process with an emergent, negotiated technical solution is that of the joint ITU-T Video Coding Experts Group and the ISO/IEC Moving Picture Experts Group, which resulted in the H.265 or High Efficiency Video Coding (HEVC) standard. "At its first meeting in April 2010, the [joint groups] studied the proposals submitted (…) and established the first version of a test model (…), which was produced collectively from elements of several promising proposals (…). Although [it] showed significant coding efficiency improvements compared to prior standards, it had several redundant coding tools in each functional block of the video compression system, primarily due to the fact that [it] was a collective design from various contributions. During the second meeting in July 2010, the process began of selecting the minimal necessary set of coding tools for each functional block by thoroughly testing each component (…). Based on the reported results (…), [a next] test model version and the corresponding (…) working draft specification (…) were produced as outputs of the third meeting in October 2010. Compared to the prior (…) design, [the current design] was simplified greatly by removing coding tools that showed only marginal benefits relative to their computational complexity." [29, p. 1666]

Given the different interests and performance requirements of participants to standardization, the complexity of technical solutions often sought in ICT and the influence of standards procedures, the emergence of a technically 'best' solution' is not self-evident. These issues are successively addressed below.

4.1. Clarity of performance requirements

Standardizers perceive some technical solutions as better than others [i5, i8, i6][10], although often only marginally so [i7]. In the ITU, work on an optical standard was stopped because the patent owner of the preferred solution refused to license its technology. A design-around alternative was then developed. "Work-arounds are always possible, but you would want the best solution."[i5]

Whether the best solution ends up in a standard, depends on many factors that may have little to do with technical merit [i6]. This is not specific to 'coordination by committees' (committee standardization); it is the same for 'coordination by markets' (de facto standardization), as the outcome of the classic VHS – Betamax – Video 2000 video recording battle illustrates.

Key for comparing technologies is a clear set of performance requirements and a uniform way of testing to what degree proposed solutions meet them. In the example of speech coding standardization, the committee defined their terms of reference ahead of time (i.e. the selection criteria for choosing among technical contributions). Tests were developed upfront. The contributions were black-boxed (i.e. their company source anonymized) and then tested on their technical merit [i5, i8]. However, in many cases and for different reasons, performance requirements are often not that clear-cut. Committees may start out with only a loose set of goals that indicate a general direction of standards work to be done [i8, i3]. See, for example, the broad technical scope of the 3GPP committee on 5G [i6]. Note: these general goals can be highly concrete. For example, the goal of joint standardization on H.265 was "to enable significantly improved compression performance relative to existing standards—in the range of 50%

An Assessment in Light of Recent Academic, Policy and Legal Evolutions' (Liege Competition and Innovation Institute, University of Liege, Brussels, Belgium, February 29, 2016).

[10] For example, according to Baron et al. [31], quoted in [13] "The choice of standard specifications takes place ex post in ad hoc working groups, based on the merit of rival technologies available to solve a given technical problem. Firms thus compete in R&D ahead of the working group meetings (…) This formal process generates costly R&D duplications and delays due to vested interests (…)."

bit-rate reduction for equal perceptual video quality" [29, p. 1649].It was not clear at the outset how these goals were to be met.

As a rule, the broader the scope, the more technical alternatives to consider. For example, standards work on a framework for video surveillance did not start out with specific requirements. Too much depended on the contributions coming in. [i8] Participants learn as they go [i8], and different approaches emerge along the way. [i3] However, once the cornerstones of the architecture have been set – one interviewee speaks of a battle of ecosystems [i13] -certain technologies will be more suited than others [i6, i11, i5]. The possible arbitrariness of initial choices is referred to in [10, p. 608]:"[A] standard could be built around initially arbitrary choices that become essential once the standard is established."

Where performance criteria have been set, it can be difficult- even for insiders - to assess whether a technical solution for an ICT standard is better. Bessen and Meurer note that "(…) software technologies (algorithms, system structures) can be represented in many different ways, and it might be difficult to know when alternative representations are [not] equivalent. (…) "[Often] computer scientists cannot unambiguously make these distinctions (…)" [30, p.23]. Whether this observation about software applies to ICT more generally, needs to be confirmed. However, software makes out a significant part of ICT. As two interviewees remark, hardware is increasingly a software matter [i9]; the distinction between the two is blurring (e.g. in telecommunication networks these are coined as 'software defined networks') [i8].

4.2. Multiple design choices and performance criteria

From a practitioner's perspective, standardization is a matter of hundreds of interrelated design choices and many technical components rather than a choice between 'technologies' [i13, i5].The latter term, more current in academic literature and policy documents, may mistakenly imply the presence of well-defined indivisible entities to choose between.[11] (In the remainder of this section, the term 'technology' will be upheld; but the point made will be readdressed in the concluding section.)

Moreover, ICT standards typically involve multiple performance dimensions [i5, 16], some of which are technical. Requirements pertaining to the aforementioned H.265 standard, for example, include "coding efficiency, ease of transport system integration and data loss resilience, as well as implementability using parallel processing architectures" [29, p.1650]. Video coding, a key area in this standard, comprises many components. "The basic source-coding algorithm is a hybrid of interpicture prediction to exploit temporal statistical dependences, and transform coding of the prediction residual signals to further exploit spatial statistical dependences. There is no single coding element in the HEVC design that provides the majority of its significant improvement in compression efficiency in relation to prior video coding standards. It is, rather, a plurality of smaller improvements that add up to the significant gain." [29, p. 1654] Economic and market-related requirements are also at stake. For example, the less complex the standard, the less costly to implement and the lower a product's energy consumption. [i5] Certain algorithms perform better in this respect than others.

Trade-offs between performance requirements, such as between image quality and coding efficiency, are intrinsic to standardization. [i8, i5] Where participants need to agree on how to weigh the benefits and disadvantages of proposed technologies along several dimensions, the notion of 'best technology' therefore makes little sense without qualification or detailed argumentation.

Multiple performance dimensions also make it highly difficultto assign value to the proposed solutions, as [16] illustrates: "Technology A may involve 'cost savings' as compared to technology B, but B is viewed as considerably more 'reliable' than A. Looking solely at the 'cost savings' dimension would be misleading for any 'incremental value' calculation. But since 'cost savings' move inversely with 'reliability' under this trade-off, combining both dimensions in a scoring function is unlikely to be helpful either: such an index would simply suggest the midpoint compromise, with moderate cost and moderate reliability, (…) but the hope for a formulaic incremental value calculation strikes us as unrealistic."[16, p.66]

[11] [i13] notes: "You cannot identify 'a technology' in a standard, as the research question seems to suggest." He reserves the term 'technology' for a specific kind of engineering solution (e.g. optical technology) or to refer to other standards (e.g. GSM technology).

4.3. Choice as filtered by consensus versus voting committees

Perceived technology choice is also affected by features of the standards process, that is, by procedures of standards setting organizations (e.g. different membership and voting rules [i3], decision procedures and IPR policies)next to number, kind and diversity of contributors, etc. [i2].

Two interviewed chairs of standards committees [i3, i4] especially underline the influence of consensus decision making on technology choice, thereby qualifying outsider perceptions of what the 'better' standard's outcome may be. Consensus refers to a "General agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments." [23] Striving for consensus is, as a rule, taken very seriously in committees and working groups of formal SSOs like ISO, IEC and ITU, and in some standards consortia (e.g. W3C [i3]). The dynamics in consensus-oriented committees strongly differs from committees of SSO in which voting is more accepted (e.g. OASIS and IEEE).

Among 'voting committees', however, also large differences exist. Not just because some committees may only turn to voting as a last resort while others may do so as a matter of course; but also due to differences in voting rules. In some SSOs, a simple majority vote is needed (50% +1); in others larger majorities are required. Moreover, in some committees every member has one vote while in others weighted voting exists. In e.g. ETSI, the weight assigned to a member's vote is proportionate to a company's market share (and membership fee). The larger its share, the more weight its vote carries. Both weighted voting and the kind of majority needed strongly affect standards strategies and negotiations at working group level, especially if compared to those in 'consensus committees'.

While in some cases the outcome of deciding by consensus and voting may be the same, in other instances opposite outcomes may result. "In a [consensus-committee] situation where there are two options A and B, where the majority favours A over B but somebody can't live with A, while everybody can live with B, B is the chosen option."[32] 'Absence of sustained opposition' means that the best outcome is a solution 'all parties can live with'. [i3]

Consensus is easier to achieve in some committees than others. If committee members have known each other for a long time, it is easier to resolve disagreements and reach compromises.[i4] Where consensus cannot be achieved, for example, because parties feel their contribution is excluded or they object to the inclusion of an option, standards committees can usually escalate to a higher level of decision making in the standards body (e.g. in the ITU [i8]) "Most important is a workable standard, one that creates interoperability. (...) This requires a level of openness and a willingness to share among competitors." [i4] The worst outcome results if everyone sticks to their standpoint [i3]. The consensus process then becomes political and more likely leads to a technically weak compromise. [i3] For example, in the case of HTML standardization, two camps opposed each other: the web browser industry and the users. Industry support was needed to get the technically superior option. In its absence, the process became more political and the agreed solution technically inferior. [i3]

Tying the influence of standards procedures on technology outcome to performance requirements and technology choice, it is easy to see that incumbent market players have a disproportionate influence in 'voting committees' vis a vis newcomers. [i3] Either because of existing market dependencies and easier access to alliance formation; or, where weighted voting is in place, because sizeable market players more easily get their performance requirement prioritized. Standardization will therefore sooner perpetuate existing market structures and the position of incumbent players. Thus, theoretically technology choice may exist – either between significantly different or roughly equivalent solutions- as all participants may bring theirs to the negotiation table. But in practice choice is pre-filtered by existing market power. This is more so in voting committees than consensus committees.

4.4. Technical merit and the nature of standardization

Interwoven with technology choice is the question posed earlier: Is standardization about choosing the 'best' technology (innovation angle), or about arriving at *a* common agreement, irrespective of the technology chosen (market coordination angle)? In neither consensus nor voting committees the prior aim seems to be getting the best outcome technology-wise [i4, i7]. The first prioritizes an agreement 'which all parties can live with'; the second prioritizes reaching a timely decision. The technical merit of solutions is highly relevant [i5] but ultimately subsidiary to reaching an agreement, to most standardizers. [15]

Companies typically dominate ICT standards processes. From their perspective, standardization is, next to pre-competitive collaboration, a way of pursuing market competition by other means [i2, i12, 24]. For those who seek a standard, having *a* standard is more important than having a particular standard; their aim is producing a saleable, interoperable product rather than a superior product [24, pp.23-24]. For others, it may be in their business interest *not* to have a standard since standards often increase competition (i.e., open up the market to newcomers). Such companies, those that have not yet secured their market share as well as those well-positioned to compete in a non-standardized market, may nevertheless participate to sustain room for differentiation or even to slow down the standards process (e.g. by introducing complex requirements or making progress harder to achieve otherwise [i2]). "The politics (…) start the minute that an activity is first proposed and continue throughout the life of the activity. (…) The potential for intrigue (and betrayal) is significant. (…) It is not the technical love-fest of cooperating technologists." [24, p.27] This pleads for framing standardization as an economic-political process rather than a technical one [25, 26].

Is the inclusion of new technical solutions and innovation a goal of standardization? In the definition of formal standards bodies, the term 'standard' refers to "a document, established by consensus (…) that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context" [23, par. 3.2]. 'Optimum degree of order' says little about the innovativeness of the technology chosen and foremost seems to address market order. More clarifying is the footnote: "Standards should be based on the consolidated results of science, technology and experience, and aimed at the promotion of optimum community benefits." [23, par. 3.2] This more explicitly states that novelty is not aimed for. According to the interviewees, this applies to (consensus-oriented and voting oriented) formal standards bodies as well as consortia, with one exception [i13]: the 'proof-of-technology' industry consortia [27, p.562].[12] These are, however, more apt characterized as a form of de facto standardization [27] rather than committee standardization, and fall outside the scope of this paper.

5. Conclusion

From the standardizer perspective, the question raised at the dinner debate 'whether standardizers are usually faced with significantly different (i.e. more or less) innovative technologies, or with relatively arbitrary type of technical decisions' is contentious. It cannot be answered unequivocally, foremost, because it contains incorrect implicit assumptions about what standardization entails. First, the term 'technology', which suggests an identifiable entity in a standard, conceals the many interrelated technical design choices and components usually at stake in standardization. Second, performance criteriaare needed in order to compare the value of technical solutions. These may not be clear at the outset and are subject to negotiation between parties with different interests and priorities. Moreover, in most cases multiple criteria are involved and choosing is a matter of trade-offs. Third, many committees begin with a broad technical scope (i.e. a general goal without clear-cut criteria). Initial - rather arbitrary -architectural choices determine the value of subsequent technical proposals. Fourth, even insiders often have difficulty assessing which solution is better. Fifth, the negotiation context – i.e., consensus versus voting committees – strongly filters standardizer perceptions of technology choice. Sixth, standardization as 'competition by other means' highlights the influence of non-technical factors

[12] The function of 'proof-of-technology' industry consortia "is to smooth the way for acceptance of a new technology by beginning the consensus process during technology development. (…) [They] provide a place for competing vendors to meet and work out the concepts of the technology prior to making major investments." [27, p.562] These consortia seek "precommittee consensus (i.e., a de facto standard) around a particular approach to a technology". Their aim is to divert future committee or market rivalry, and (…) influence the market very early. " [27, p.562] An example is the Wireless Power Consortium. Therein, technical problems encountered during meetings are addressed off-line by individual consortium members. This may lead to new (patented) inventions, which are then considered for inclusion in subsequent consortium meetings. In effect, joint technology development takes place. [i13] Wasteful R&D duplication that occurs is seen as the lesser evil than the emergence of competitive standards in a new market [28].

on technology choice.

Given the significance of these caveats, talking about 'more or less innovative technologies' in a standardization context would seem to have little practical substance. The research question cannot be answered meaningfully without overly crude simplification. A further, complicating factor is that even the underlying supposition about the relevance technical merit cannot be answered univocally. Technical merit is important but, ultimately, secondary to reaching an agreement. This puts into perspective the value of including technically 'moreinnovative' patented solutions in standards.

5.1. Implications

What are the implications of these findings for the valuation of SEPs?[13] Although the paper's perspective differs from those in legal and economic studies, the findings confirm the relevance of taking aboard

- Alternative technical solutions. Given the overriding influence of non-technical factors on technical choice, there is little ground to think of standardization as a process that selects the superior technology. To reward a patent holder as if it was, contradicts the overall perception of standardizers that, in many cases and at different moments in the standard process, alternative solutions exist (e.g. royalty free design-arounds and patented solutions). Whether this is best addressed by courts in estimating reasonable royalties by considering "(…) the value of the patented component *in comparison with the next best, noninfringing alternative way to create that component"* [4, p. 2039] or by other means, requires further study.
- Multiple performance dimensions. Standardizers usually choose among alternative technical solutions according to multiple criteria (e.g. coding efficiency, data loss resilience, implementability etc.). Companies have different tradeoffs, which are part of standards negotiations. This finding endorses the view that these multiple performance dimensions should be considered when assigning value to patents [16], even though it might severely complicate patent valuation:"(…) the hope for a formulaic incremental value calculation strikes us as unrealistic." [16, p.66]

5.2. Research recommendations

On some more general issues research is recommended.As noted earlier, there is discussion about ex ante licensing disclosure and price commitments for patented solutions [19, 20], a practice which has already been implemented in some SSOs [6, 20]. Early information clearly allows committee participants to better appraise the cost implications of technical choice. However, for committees with a broad technical scope there is a tension between static initial commitments, on the one hand, and, on the other, the dynamics of interdependent successive technical choices and corresponding crystallizing performance criteria, pointed out in this paper. On what criteria are initial company commitments based? Would initial price commitments be more modest if set behind Rawls' 'veil of ignorance' [34] and in the knowledge of technical choice, interdependencies and shifting criteria? This needs to be studied further.

Moreover, the incorrect implicit assumptions noted above reveal a mismatch between academic theory and standardization practice. Their fundamental nature calls for a systematic review of existing literature in the light of the above findings.

Finally, the findings contextualize technology choice, highlight the (unmeasured[14]) value of standardization agreements, and put into perspective the value of including 'more innovative' solutions in standards. Serious concerns have been voiced regarding "the impact of SEP litigation on the standards ecosystem" [35] resulting from the inclusion of patents in 'agreements intended for common and widespread use'. The tension between the private character of patents and the public nature of standards [7] challenges the current patents-in-standards system. Its sustainability deserves further study.

Acknowledgment

[13]Please notethat SEP valuation is an area of expertise on which the interviewees were not questioned.

[14] Efforts to measure the value of standardization are partial and often inadequate. [33]

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Interviewed Experts

[i1] Pieter Hintjens, iMatix Corporation, e.g. OSS developer, former part. in AMQP&NBN standardization
[i2] Paul Coebergh van den Braak, Philips IP & Standards, Sr.Dir. Standardization, VC of PCHA, member IEC CB
[i3] Arnaud Le Hors, IBM, STSM, e.g. former IBM Software Standards Architect,previously worked for W3C
[i4] Anne-Françoise Cutting-Decelle, prof.Ecole Centrale de Lille, Geneva Univ., conv.ISOTC184/SC4-SC5/JWG8
[i5] Mostafa Hashem Sherif, AT&T, standards editor IEEE Comm. Magazine, previous part. in e.g. IEEE&ITU tc's
[i6] Hermann Brand, ETSI, Director Innovation
[i7] Ton de Liefde, TDL Advies, e.g. former advisor to ETSI and participant in NELO
[i8] Simão de Campos Neto, ITU, Counsellor for ITU-T Study Group 16 on Multimedia
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