Intellectual Property Disclosure in Standards Development

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Abstract: Firms often collaborate to produce inter-operability standards so that independently designed products can work together. When this process takes place in a Standard Setting Organization (SSO), participants are typically required to disclose any intellectual property rights (IP) that would be infringed by a proposed standard, and asked for a commitment to license their essential IP on fair, reasonable and non-discriminatory terms. This paper describes the IP disclosure process, and provides an overview of a publicly available IP disclosure dataset that the authors have compiled using the archives of thirteen major SSOs. We use these new data to illustrate several major trends in standards development, and to show how "declared essential" patents differ from a random sample of patents of the same vintage covering similar technology.

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1. Introduction

Firms often collaborate to produce inter-operability standards so that independently designed products can work together. Compatibility standards are especially important in the Information and Communications Technology (ICT) sector, where they help launch new markets and promote major upgrades to existing platforms. However, new standards may fail to produce these catalytic effects if users fear that they are built on proprietary technology and therefore carry substantial legal or financial risks. Standard Setting Organizations (SSOs) address this concern by requiring members to disclose relevant patents during negotiations over the design of new standards, and by seeking a commitment that any essential intellectual property (IP) will be licensed on liberal terms.

This paper uses data from the publicly available intellectual property disclosure records of thirteen major SSOs to characterize the IP disclosure process, describe several broad trends in ICT standard setting, and explore the unique characteristics of patents that are "declared essential" to industry standards. The authors are placing these data into the public domain to promote research on standards and intellectual property. Thus, a main goal of this paper is to simply describe the data set, which combines information from 5,004 declarations listing 9,635 unique US and European patents, primarily covering digital information and communication technologies. We use these new data to document a number of stylized facts about the disclosure and litigation of declared essential patents. Some of these facts may be relevant to ongoing policy discussions. However, since they often admit several interpretations, our primary aim is to provide new measurements and enumerate possible explanations, rather than to adjudicate between theories or use our findings to propose new policy measures.

We begin the paper by describing how differences in SSOs' IPR disclosure policies influence the contents of a typical declaration. Some SSOs require firms to indicate the specific patent(s) that would be infringed by implementing a proposed standard, while others allow firms to offer "blanket" licensing commitments. These rules are naturally correlated with number of declared essential patents in our data. We also describe the

types of licensing commitments allowed at different SSOs. While the overwhelming majority of declarations contain a "Fair Reasonable and Non-Discriminatory" or FRAND licensing commitment, our data reveal many variations on this common theme.

After describing how IPR policies are linked to variation in the contents of a "typical" disclosure, we examine three broad longitudinal trends. The first trend is a remarkable growth in the total amount of IP declared to our sample of thirteen SSOs. We argue that the increase in total IP declarations over time reflects a combination of factors, including growth in patenting; increased antitrust enforcement; increased demand for standards (driven by the growth of shared platforms such as the Internet and cellular telephony); and a strategic "race" to own essential patents. The second broad trend we examine is convergence: over time, an increasing share of declared essential patents come from a few key technology classes (primarily covering communications), and there is evidence that of a shift from firms initially focused on computing (IBM, Apple) to telecommunications equipment providers (Nokia, Motorola, Qualcomm). We also find that firms increasingly declare essential patents at two or more different SSOs in a given year. The last issue we examine is vertical or business model specialization. We find that roughly one-third of the declared essential IPR in our data comes from "upstream" technology developers (e.g. patent holding companies, component suppliers and research institutes). Most of the remainder comes from firms with an integrated or downstream business model (e.g. equipment vendors and systems integrators).

In the final section of the paper, we turn from broad trends in disclosure to detailed patent-level comparisons. In particular, we show how "declared essential" patents differ from a random sample of patents of the same vintage covering similar technology. We find that our sample of SSO Patents receive twice as many citations and are almost four time more likely to be asserted in litigation than a set of matched controls. The SSO Patents also contain more claims, and cite more patent and non-patent prior art than the control sample. The difference in citation and litigation rates between SSO and "control" patents varies substantially across SSOs in our dataset, and we offer some speculation on the potential causes. We also show that patents declared with a royalty-free (RF)

licensing commitment receive more cites and are less likely to be litigated than those declared under the more common FRAND alternative. Finally, we examine the timing of IP declarations relative to the patent review process. While the median declaration occurs 1.5 years after a patent issues, a substantial number of disclosures occur shortly after the application is filed. The probability of litigation is greatest for patents disclosed when they are very young or very old (i.e. the top and bottom quartiles of the disclosure age distribution).

Although this is primarily a descriptive paper that aims to provide a quantitative overview of the IP disclosure process, our findings suggest several novel hypotheses and avenues for future research. First, the observed increase in IP disclosure over time, both within and between SSOs, could have several explanations. Future research might examine the relative contribution of these factors to the growth in "declared essential" IPR and the potential for interactions between them.

A second stylized fact that clearly emerges from our descriptive analysis is the relative importance of declared essential patents. Compared to an average patent with similar age and technology characteristics, patents declared to SSOs score considerably higher on a wide range of metrics that are correlated with value or importance. A key question for evaluating both the importance of SSOs and the potential for patent hold-up is whether these differences were caused by inclusion in a standard, or reflect a selection effect whereby SSOs and firms identify technologies that were already on their way to prominence (e.g. patents with a high technical merit). While Rysman and Simcoe (2008) use citations and the timing of IP disclosures to address this question, much more could be done. Efforts to link IP disclosures to particular standards, and to identify the dates of key technical decisions (as in Bekkers et al 2011) promise to yield better estimates of causal effects, and to show how they vary across SSOs, markets and technologies.

Finally, many of the patterns revealed in our exploration of these data illustrate the challenges that SSOs face in crafting an effective disclosure policy. For example, we find that rules regarding "blanket" disclosure have a substantial impact on the amount of IP

declared. This is natural, since it will typically be cheaper, and perhaps less risky, for firms to issue a blanket FRAND commitment that does not claim specific IPRs. However, blanket FRAND commitments are not very transparent, and may simply shift the costs of discovery onto other members of a standards committee,[1] prospective licensors and interested third-parties (e.g. courts). Similarly, we find that a great deal of IP disclosure occurs before a patent issues, when there may still be considerable uncertainty about the scope of its claims. On the other hand, allowing later disclosure may increase the risks of patent hold-up.[2] We view these timing and specificity problems, combined with the economic importance of essential patents and the inherently ambiguous FRAND commitment, as the joint causes of the high observed litigation rates of declared essential IPR. Additional work that carefully examines the circumstances behind individual lawsuits might shed light on the relative importance of these factors.

The balance of the paper describes IP disclosure policies in general, and at the thirteen SSOs in our sample (Section 2); provides evidence of the broad trends in disclosure and standardization discussed above (Section 3); examines the characteristics of US declared essential patents (Section 4); and offers some concluding remarks (Section 5).

2. Intellectual Property Disclosure Policies

In one of the first systematic studies of SSO intellectual property polices, Mark Lemley (2002) suggests that they typically have three components: search, disclosure and licensing rules. Since few of the SSOs in his study, and none of the thirteen organizations that we examine below, have a mandatory search rule, our discussion will focus on policies governing disclosure and licensing. Disclosure rules specify how and when firms must notify other SSO participants that they own IP that may be infringed by a standard. Licensing rules specify the commitments that IP holders are requested to make regarding

[1] As discussed below, firms often make an informal announcement about essential IPR to a technical committee, and these announcements may precede the formal blanket declaration. We have no data to indicate whether these informal "declarations" provide more details about specific patents, and might therefore be useful to a technical committee hoping to evaluate potential trade-offs between technical quality and implementation costs.
[2] Hold-up occurs when an essential patent-owner charges royalties that exceed the *ex ante* (competitive) price for their technology, and therefore appropriates (part of) the returns to implementers' sunk investments in the standard. See Farrell et al (2007) for an overview of the extensive literature on this topic.

future licensing activities, the conditions that can be attached to those commitments, and the methods of enforcement. Table 2.1 provides an overview of the IPR policies for the SSOs in our data set, and Appendix A goes into greater detail.

Broadly speaking, there are two types of IP disclosure in our data. A *specific* disclosure lists one or more patents or pending patent applications that may be infringed by a standard. A generic or *blanket* disclosure indicates that an SSO participant may own relevant IP, but does not list any patents or pending applications.

Blanket disclosure is clearly less costly for patent holders, who are not required to search through their portfolios. Thus, allowing blanket disclosure can be efficient if the main purpose of a disclosure policy is to reassure prospective implementers through licensing commitments. On the other hand, blanket disclosure can shift search costs from a patent holder (who presumably has the comparative at finding their own essential patents) onto other interested parties. Parties with an interest in specific disclosure therefore include: prospective licensees who wish to evaluate the scope and value of a firms' declared essential patents; SSO participants who seek explicit cost-benefit comparisons of alternative technologies before a standard is chosen[3]; and courts that would otherwise use information on firms' essential patent holdings as part of a reasonable royalty determination.

The SSOs in our sample take different approaches to disclosure specificity. For example, ETSI and the Open Mobile Alliance (OMA) require specific disclosures. The IETF requires specific disclosure unless the generic disclosure is accompanied by a royalty-free licensing commitment. All of the remaining SSOs "allow" or "encourage" specific disclosures, but also permit blanket statements (see Table 2.1)

Policies that require or encourage specific disclosure typically apply to any patent that an SSO member believes to be *technically essential*, meaning that it is not possible to

[3] As discussed below, the rules of most SSOs allow formal disclosures to occur after key technical decisions are made, so this observation applies to the specificity of declarations made during the committee process.

implement the standard without infringing the IP. However, SSO participants are not required to disclose *commercially essential* patents, which cover methods of implementation that produce dramatic cost reductions or quality improvements. In economic terms, a technically essential patent has no substitutes, while a commercially essential patent has at least one (possibly weak) alternative. This distinction can be complex in practice. For example, many standards specify a menu of choices for certain features, leaving the final choice of technology to implementers.[4] In such cases, it is unclear whether most SSOs view essential patents for "optional" features as technically or commercially essential.[5]

The timing of IP disclosure is another issue that quickly becomes complicated. Most SSOs encourage early disclosure of essential patents. For example, ETSI seeks disclosures "in a timely fashion" and the ANSI IPR Policy Guidelines (2009) encourage "early disclosure." However, few SSOs provide explicit deadlines or milestones.

In practice, disclosure often has two stages: an initial "call for patents" and the subsequent filing of a formal notice or declaration. At most SSOs, there is a "call for patents" at the start of each technical committee meeting, and participants are expected to mention any IPR related to their own proposals (which may or may not become part of the standard), and may also draw attention to patents owned by others. We know of no systematic information that indicates when, or with what degree of specificity, the first stage "call for patents" is answered at any particular SSO. The second stage of the disclosure process occurs when a firm formally notifies an SSO (in writing) of essential patents for a specific standard or draft. Our data come from these letters, which we henceforth refer to as 'declarations.'

Figure 2.1 illustrates the complex relationship between key events in the patenting, standard setting and IP disclosure process using two possible scenarios. In the first

[4] The IEEE 802.11 (Wi-Fi) standards specify three possible air interfaces, only one of which is widely deployed.
[5] None of the SSOs in our data require participants to indicate whether their IPR covers mandatory features or (only) optional features of a standard. Patent pools, which are generally barred from including substitutes, exclude groups of patents that are technically essentially to alternative implementation profiles.

scenario (top panel), a patent issues before the patented invention is proposed for inclusion in a standard to an SSO. When the invention is first proposed, the owner is required to make an IP declaration in response to the call for patents – an event that is not made public. The patent holder follows up with a formal declaration (which we do observe) sometime after the publication of a draft standard, but before the final specification is approved. In the second scenario (bottom panel), all of the key standardization decisions and disclosure events occur while the patent is under review. The figure shows that the invention is submitted to the SSO and disclosed informally just after the patent application is filed. However, since there is no explicit rule on the timing of the formal disclosure, the claimant may wait until after the standard is formally approved to offer a written declaration. Thus, while formal IPR declarations can provide a great deal of information (see Appendix B), it is important to recognize that SSOs may receive them long-after the date when the IPR was first disclosed to a technical committee, or the date when the key technical decisions that determine a patent's essentiality were made.[6]

All declarations, regardless of the type or timing of the disclosure, offer some guidance about the terms that an IP owner will offer to prospective standards implementers for any essential IP. We refer to this part of the declaration as a *licensing commitment*.

The most common form of license commitment is a promise to license on Reasonable and Non-Discriminatory (RAND) or Fair, Reasonable and Non-Discriminatory (FRAND) terms. There is a substantial legal and economic literature, reviewed by Joseph Farrell et al (2009), and a considerable amount of controversy over the precise meaning of FRAND. At a minimum, it implies that an IP owner is required to enter good faith negotiations and grant a license to any firm wishing to implement the standard. Most of the SSOs in our data allow, but do not require, more stringent licensing commitments. For example, many firms promise to grant a royalty-free license to any standards implementer, or provide a covenant not to assert their essential patents.

[6] In principle, since most declarations do indicate the relevant standard, one could identify the dates of key technical decisions. However, that information can be hard to find, and the links are often messy, and standards often see improved, updated releases, so we have not (yet) taken that step.

Many firms add conditions to their licensing commitments, through SSOs vary in their willingness to allow free-form declarations. Common conditions include defensive suspension provisions (which terminate the FRAND commitment if an implementer sues the essential patent holder for infringement) and reciprocity requirements (which makes the FRAND commitment conditional on receiving similar terms from an implementers who also holds essential patents). However, our sample of declarations also contains a wide variety of different licensing conditions, including field-of-use restrictions, and GPL-like provisions that make the offer of a royalty-free license conditional on reciprocal royalty-free commitments from any prospective implementer. Over time, commonly used conditions may become part of an SSO's IPR policy, for example, as an option on a standardized form used to collect declarations.

Licensing commitments also vary in scope, depending on the type of disclosure as well as the IPR policy at the SSO. For a specific disclosure, the licensing commitment may apply to only the disclosed patents, or members of the same patent family. For a blanket disclosure, the licensing commitment could apply to a particular standard (document), to all work by a particular technical committee (Working Group), or even to the entire SSO. Many declarations combine a specific disclosure with a blanket FRAND commitment that covers all work on a particular standard.

SSOs' intellectual property policies typically specify a set of procedures for dealing with the (rare) event that a firm is unwilling to offer a licensing commitment for essential IPR. In most cases, the SSO will halt work on the standard in question, and investigate opportunities to invent-around the essential patents. If these efforts fail, the SSO might stop working on the standard altogether, or withdraw a specification that was already issued.[7]

[7] To some extent, SSOs are able to rely on third-party enforcement. Antitrust authorities have brought several cases against firms that conduct "patent ambush" by seeking a license after they failed to disclose essential patents. Courts have also issued rulings that clarify some aspects of FRAND (though not necessarily pricing).

The data we examine below come from publicly available IP disclosure records, and most SSOs provide a set of standard disclaimers with their disclosure data. These include: (1) The statements are self-declarations and the SSO takes no responsibility that the list is complete and correct, (2) members agree to reasonable endeavors to identify their own essential IPR, yet do not have an obligation to perform patent searches, (3) it is up to the patent owner and the prospective licensees themselves to negotiate licensing agreements, and (4) the SSO does not handle disputes; in such cases, parties should go to court.

Beyond these standard disclaimers, SSOs differ in what they require, what they (explicitly) allow, and what they seem to tolerate in practice. The formal requirements may be part of the IPR policy itself (usually these are binding rules, such as statutes, by-laws, or undertakings), but may also become clear from the administrative procedures, such as templates that firms should use for their declarations, or from the actual declarations that are made public. Table 2.1 provides an overview of policy differences among SSOs in our database, Annex 1 provides a more detailed description for each SSOs, and Annex 2 provides references and links to the actual policy documents, guidelines, disclosure templates, and databases of IPR statements.

3. Disclosure Data: A First Look

This section uses our database of intellectual property declarations to document a number of stylized facts about the evolution of standards and intellectual property over the last two decades. We focus on three broad patterns: (i) the sustained growth in IPR declarations, (ii) a growing emphasis on communications technology, and (iii) vertical or business model specialization.

Our analysis is carried out using the IP disclosure dataset described in Appendix A. These data contain 45,674 disclosures (i.e. general or specific licensing statements) that can be grouped into 5,004 declarations (i.e. statements submitted to a single SSO by a single firm on a given date). Table 3.1 summarizes the total number of declarations and

declared essential patents in our data. Note that the distribution is very uneven: some SSO's 'attract' large numbers of patents, others hardly any. These differences reflect the scope of the work carried out within the SSO, the different IP policies summarized in table 2.1 and differences in the patenting propensity of member firms.[8]

3.1 Growth in Disclosures

Figure 3.1 shows the total number of declarations in our data, along with the average annual disclosure size (i.e. the mean number of US and EPO patents per declaration), starting in 1990. This figure exhibits two striking features: the sustained growth (and acceleration) in total declarations, and the sharp increase in disclosure size around 2000. Table 3.2 shows that the increase in disclosure size is linked to a small number of declarations that list very large numbers of patents, particularly at ETSI. The remainder of this sub-section considers several potential explanations for the ongoing "disclosure boom."

Changes in Disclosure Policy and Enforcement

Between 1990 and 2010 many SSOs altered or clarified their disclosure policies in ways that encouraged declaration. For instance, the first patent disclosure at the IETF occurred in 1995, and it took several years for the organization to settle on its current policy, which only allows for blanket disclosure if a firm is will to make a royalty free licensing commitment. The IEEE revised its IPR policy in 2007. Among other reforms, the new IEEE policy allows *ex ante* disclosure of licensing terms and encourages disclosure of third-party patents

The enforcement of SSO IP disclosure policies has also changed over the last two decades. In general, SSOs have limited powers of enforcement. While they might threaten to expel firms that fail to comply with an IPR policy, we could find no examples of this approach. Several SSOs indicate that they may withdraw support for a standard if

[8] A high number of claimed essential patents can be found at SSOs focusing on telecommunications standards: ETSI, IEEE, ITU, IETF, and OMA.

an essential IP holder refuses to commit to RAND licensing. However, this threat will be weak for standards that have already achieved market acceptance. In practice, few firms are unwilling to make a RAND commitment, perhaps because it leaves them with considerable pricing flexibility.

Nevertheless, enforcement of SSO IPR policies was strengthened, starting in the early 1990s, as the result of several court cases.[9] In 1993, Mitsubishi prevailed in a suit against Wang Labs, who had claimed infringement of two patents that were not disclosed to an SSO. In 1995, the FTC settled a similar matter against Dell Computer, who ultimately agreed to waive certain IP rights that it had failed to disclose. Perhaps the most famous recent case on this issue is the matter of Rambus, which raises a host of thornier questions about when a firm comes under the obligation to disclose IP, and what types of IP it must reveal. The cumulative effect of these cases is a reasonable fear that failing to disclose essential patents could lead to forgone licensing revenue. Thus, firms may have become more vigilant regarding IP disclosure beginning in the mid 1990s.

Standardization Activity

The volume of IP disclosures is clearly tied to the number of standards under development, and there is anecdotal evidence of an increase in standards development during the 1990s as a number of important markets coalesced around "open" product architectures. For example, Bresnahan and Greenstein (1999) describe the transition to an open architecture for personal computers in the mid 1980s. Simcoe (2012) shows that the emergence of the commercial Internet around 1995 is linked to a substantial increase in the size of the IETF. This period also saw important standards work in the rapidly advancing field of wireless telecommunication, especially within ETSI and 3GPP.

Figure 3.2 shows that IETF, IEEE and ETSI account for a substantial share of the growth in total IPR declarations in our database. These three SSOs are closely associated with the Internet, the 802.11 wireless networking standard, and cellular telephony. Thus, the

[9] See Kobayashi, B. H., & Wright, J. D. (2010) for an overview of the legal issues.

figure suggests a link between platform growth and increasing amounts of IP disclosure.[10]

Patenting and Licensing

Increased patenting is another potential explanation for the growth in IP disclosure at SSOs. The long-term increase in US patent issuance is widely documented, and scholars have suggested several underlying causes. For example, Hall (2007) suggests there was a structural break in the growth rate of US patent applications in 1984, shortly after the creation of the Court of Appeals for the Federal Circuit. Texas Instruments famously began its aggressive licensing strategy in 1985.

Firms also became more sophisticated in their use of patents between 1990 and 2010. One example is the reappearance of patent pools in 1997 with the creation of a pool for the MPEG-2 digital video standard.[11] Almost every subsequent pool has formed to license patents that are essential for industry standards. Several firms have also been very successful at unilaterally licensing their standards essential patents. The leading example is Qualcomm, whose portfolio of CDMA patents earned billions of dollars in annual licensing revenue during the mid 2000s. Large implementers and systems integrators have also worked to create portfolios of essential patents, partly for "defensive" use in cross-licensing negotiations. Table 3.3 illustrates the increasing number of companies declaring essential patents.[12] In Section 4, we examine a number of patent-level outcomes (e.g. citations and litigation) that illustrate the strategic value of declared essential patents.

Industry Structure and Business Models

Changes in industry structure are a final contributing factor to the boom in IP disclosure. Prior to the 1990s there may have been less need for IP disclosure as part of the standards process, since the firms developing and implementing standards were often large,

[10] An interesting topic for future research is whether declared essential patents cover "core" technologies that are essential to the underlying platform (e.g. networking protocols), or adaptations that make the platform more useful in specific markets or applications, and whether this shifts over time.
[11] Lerner et al (2007) describe how pools were common in the early 1900's, but disappeared around the 1950s due to antitrust concerns.
[12] While most "claimants" (companies who disclose IPR) are the actual patent-owner, this is not always true for at SSOs that allow for third-party declarations.

vertically integrated companies that exchanged rights under broad cross-licensing agreements. The emergence of more "open" product architectures, and the growth in markets for technology, have led to more vertical dis-integration (i.e. outsourcing the design and manufacture of components) for many ICT products.

Intellectual property naturally receives more attention in a vertically dis-integrated industry structure, since it helps determine the distribution of profit across the value chain. For example, specialized technology developers, such as Qualcomm, Rambus, or the fabless semiconductor firms described in Hall and Ziedonis (2001), rely heavily on IP rights to capture a share of innovation rents, and recognize the potential value in holding essential patents.[13] At the same time, standards implementers who license key inputs will recognize IP disclosure and licensing commitments as tools for promoting *ex ante* competition among technologies and avoiding *ex post* hold-up by licensors.

We have classified the "business model" of 331 different organizations that filed one or more declarations in our data set, and Table 3.5 shows the distribution of "upstream" and "downstream" players. Between 1990 and 2010, 40 percent of all claimants came from "upstream" categories, i.e. patent holding companies, individual patent holders, component suppliers and research institutes. These organizations made roughly 20 percent of the declarations in our sample, and those declarations listed roughly 30 percent of the declared essential patent families. Firms in the two "downstream" categories – equipment suppliers/system integrators and service providers -- comprise 50 percent of claimants, made 70 percent of the declarations, and their declarations contain 66 percent of the declared essential IPRs. We discuss differences in the declaration style of these different "business models" in sub-section 3.3.

In summary, this sub-section identified four broad factors that contributed to the ongoing growth in IP disclosures: changing policies, increased demand for standards, increased patenting and changing industry structure. Each of these trends are part of a mutually

[13] For example, Simcoe, graham and Feldman show that smaller specialized firms are more likely to litigate their declared essential patents following disclosure.

reinforcing set of changes in the structure of IT and telecommunications markets, and it is likely that all of them contributed to the ongoing "disclosure boom."

3.2 Technological Convergence

Many ICT industry observers argue that increased digitization of content, improved search capabilities and inexorable improvements in general purpose computer capacity have led to the led to the integration of previously disparate products and technologies. This idea is perhaps best illustrated by "smartphones" that now typically include a web browser, a camera, a music player, and much more. Has convergence led to greater breadth in the range of technologies covered by declared essential IP? Our evidence is mixed. The increase in IP disclosure has led to declarations covering a broader range of technology classes over time. However, patents covering wireless transmission of digital content have experienced disproportionate growth, so the overall distribution of declared essential technology classes has become more concentrated. Similarly, while firms are declaring IP to a broader range of SSOs over time, the top four firms consistently account for roughly 50 percent of the declared essential patent families.

Table 3.4 uses the International Patent Classification system to examine the technology classes of declared essential patents. The total number of IPC classes is increasing over time.[14] This is not particularly surprising given the large increase in total disclosures. However, the table also shows that the distribution of technology classes in becoming more concentrated. In particular, the Herfindahl index for all IPC classes doubles between 1990 and 2010, and the total share of the top four IPC classes (C4) increases from 50 to 70 percent. It is also interesting to look at the technology classes that account for the largest share of disclosures over time. Prior to 1995, the largest IPC classes included technologies for data compression and making physical connections. Between 2000 and 2010, the four largest categories all covered wireless data transmission.

Technological convergence might also lead firms to join more SSOs, since their own core technologies are now expected to inter-operate with a broader range of complements. Figure 3.3 shows the mean number of SSOs where all claimants file a declaration in a

[14] See the number of IPC per year in Figure 2A in Appendix.

given year. This figure climbs from about 1.2 SSOs per claimant-year to about 1.6 SSOs per claimant-year over our sample period. We also find (in unreported analyses) an increasing number of firms that make declarations at 5 or more SSOs in a given year towards the end of the sample period. This is driven by the increased activity of a small group of very large firms that account for a substantial share of total disclosure activity (as illustrated in Table 3.3).

While the figure suggests convergence, to the extent that key contributors are asserting IPR across many SSOs, it is not clear whether this is driven by increasing inter-relatedness of the work done at different SSOs, the general purpose nature of certain key technologies that span many SSOs, or the profitability of a "business model" that leads firms to seek IPR that is essential to many different standards. Each of these factors is arguably a form of convergence, but the next sub-section will focus on the question of business models.

To summarize the evidence in this sub-section, we find that the "disclosure boom" is associated with both increased technological breadth and increasing participation in multiple SSOs. However, in both cases we also find evidence that overall disclosure activity is becoming more concentrated in a few key technologies and firms. It is important to recognize that these findings reflect the combined effect of changes in disclosure rules and norms, and changes in overall standardization activity. Many firms participate in SSOs without declaring IP and many important standard-setting efforts may not appear in our disclosure data. Nevertheless, our findings point to the growing importance of declared essential patents in general, and in particular for wireless communication technology.

3.3 Business Models and Disclosure Practices

Section 3.1 discussed the hypotheses that ICT industries have moved towards greater vertical specialization, and therefore exhibit a greater variety of business models. This section asks whether firms with different business models exhibit different disclosure behaviors.

To answer this question, we assigned 331 out of 922 total claimants in our database to one of eleven business model categories.[15] While any such classification is inherently subjective, we found that it was often (though not always) relatively easy to assign organizations to a particular category. We also focused on firms that made more than a handful of declarations, so that our sub-sample of 331 organizations account for just over 80 percent of all declared essential IPR.

Table 3.5 provides a number of descriptive statistics that characterize IP disclosure shares and patterns by business-model category. We have already described how a heterogeneous group of "upstream" organizations – component suppliers, patent holders, and research institutions – make roughly one-third of the declarations, leaving two-thirds to the relatively larger set of "downstream" system integrators and equipment vendors. This table also shows that the downstream organizations are more likely to use blanket declarations when possible. In particular, 60 percent of the declarations from integrators and equipment providers are blankets, and that is nearly four times the rate of component suppliers, who at 15 percent have the next highest share of blanket declarations.

Table 3.5 also shows differences in the disclosure size, i.e. the number of unique patents or applications listed in a declaration. While "pure upstream" patent holders account for a small share of total declarations (3.6 percent), they tend to list a large number of individual IPRs, leading to a much greater 10.6 percent share of total declared essential patent families. At 7.4 unique IPRs per declaration, component suppliers also have a relatively large average disclosure size.

Table 3.6 examines the distribution of business models at the largest SSOs in our database. The "downstream" category of equipment suppliers, product vendors and systems integrators is uniformly the largest group, and typically accounts for 50 to 65 percent of the organizations that declare essential IPRs. However, there is also some evidence of differences in disclosure rates of other business models across SSOs. For example, the ITU seems to attract many more service providers, the IEEE and IEC

[15] See Table 3A in Appendix for the complete list and frequencies.

(JTC1) receive more declarations from component and semiconductor firms, and software firms play a greater role at ANSI and the IETF. We have not tested the statistical significance of these between SSO variations, but they seem consistent with the different types of standardization activity carried out at each SSO.

Finally, in Figure 3.4 we examine the geographic distribution of firms in the largest business model categories. Overall, we see that nearly all companies are American, European, or Japanese. The United States has a large share of the pure upstream patent holders, component suppliers (including semiconductor) and software firms. Service providers are evenly distributed between the US, Europe and Asia, as one might expect. Research institutes and equipment suppliers are the most fragmented and geographically diverse business model categories.

Overall, this section has illustrated and offered some explanations for the dramatic increase in IP disclosure over the two decades, and presented a variety of new statistics that show how declarations of essential IP are distributed across technologies, firms and business models.

4. Declared Essential Patents

This section takes an initial look at the declared essential patents contained in our data. While the declarations list patents from many countries, we limit our patent-level analyses to a group of 5,771 granted US patents that were either declared essential, or share a common priority application with an EP declared essential patent.[16] The United States was the most common issuing country in our overall dataset, and limiting the analysis to US patents keeps the presentation and interpretation of statistics relatively simple.[17] Henceforth, we refer to this sample as the SSO Patents.

[16] Our final sample contained 4,870 declared essential US patents and 901 US family members of a declared essential EP patent. Our full dataset attempts to clean and match all intellectual property issued by the EPO and USPTO. The EP patent to US patent matching was done using the PATSTAT DOC-DB family identifiers. (Limiting the analysis to US declared essential patents produces similar results.)

[17] Earlier studies have observed significant differences in citation behaviour at different patent offices, for instance (See Criscuolo & Verspagen, 2008).

As a point of comparison, we also created a sample of "Control Patents" by randomly choosing an undeclared US patent with the same primary (3 digit) technology class, application year and grant year as each of the SSO Patents. This one-to-one matching procedure ensures that the joint distribution of technology classes, issue years and pendency lags is identical in the two samples. To be clear, the "control" patents are not meant to provide an estimate of the counter-factual outcomes for SSO Patents had they not been declared essential. Rather, these controls yield an estimate of the "average outcome" in a set of patents with similar ages and technical characteristics. Rysman and Simcoe (2008) discuss this type of matching in detail, and note that a simple comparison of the SSO and Control patents will measure both *selection effects* (differences that would exist regardless of the SSO) and *marginal effects* (i.e. differences caused by disclosure and/or standardization).

Since the IP declarations are an not ideal data source in all respects, it is worth reiterating several caveats before presenting the results of our patent-level analyses. First, these data do not contain all essential patents, since many SSOs allow blanket disclosure. We know of no easy way to identify undeclared essential patents, short of a thorough search based on a particular standard. Second, our sample of SSO Patents almost certainly contains patents that are not truly essential. Both standards and patent applications change over time, so a patent or pending application that was essential to a particular draft may no longer be infringed by the time an SSO settles on the final specification. Firms may also "over declare" out of caution (since non-disclosure could render their IP unenforceable) or because they have a strategic motive to inflate their declared essential patent counts, possibly with an eye towards future license negotiations. Finally, when we examine disclosure timing, it is important to recall that declaration dates are only loosely connected to the underlying standards development process. Depending on the rules of a particular SSO, formal declarations can predate the key technical decisions, occur at roughly the same time, or appear long after a standard is published and diffused.[18]

[18] Our database provides details on the underlying technical committee and document wherever possible, and we encourage enterprising researchers to supplement these declarations data with more precise dates of key technical decisions as part of future research.

4.1 SSO Patent Value Metrics

Table 4.1 provides an initial comparison of the SSO and Control Patents. The main message of this table is that SSO Patents score higher than Control Patents on a variety of metrics used to proxy for value and technological significance. All of these differences are large and statistically significant.

The first three rows in Table 4.1 examine "long run" differences between SSO and Control patents. The first row shows that the probability of litigation is more than four times higher in the sample of SSO Patents: 6.81 percent versus 1.54 percent.[19] The second row shows that SSO Patents are cited as prior art by other US patents at roughly twice the rate of Control Patents.[20] And the third row in Table 4.1 shows that international patents cite the SSO Patents twice as frequently as the controls. While it is hard to place a value on a forward citation, or understand the precise significance of a particular lawsuit, these measures are widely used and rarely show differences of the size and statistical significance observed in this comparison.

The next four rows in Table 4.1 examine indicators of the perceived value of a patent to an applicant when it issues. For example, firms will typically file for protection in more countries when a patent is perceived to have greater value. In our sample, the "family size" of the SSO Patents is roughly twice that of the Control Patents. The SSO Patents also contain more claims, and make more references to both patent and non-patent prior art. These metrics suggest that the SSO Patents are "broader" than the controls and that applicants were more careful to delineate the underlying innovation (relative to prior patents) in an SSO patent application.

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[19] We measure litigation at the level of the individual patent, so a suit that incorporates two or more declared essential patents may be counted more than once.

[20] While the matching process naturally controls for cohort and technology class, we ran a pair of regressions that produces very similar estimates to the cross-sectional comparisons in Table 4.1, In particular, a Poisson-QML regression with a complete set of issue-year and technology class fixed effects suggests that SSO patents receive 95% more citations. A linear probability model with the same set of controls finds that the difference in litigation probability is 5.3 percent. Both results are statistically significant at better than the 0.1 percent level.

The large *ex ante* differences between SSO and control patents – in terms of countries, claims and prior-art references – suggest a large selection effect. In other words, SSOs attract high-value technologies. However, Bekkers et al (2011) show that firms often file for patents and submit the underlying technology to an SSO almost simultaneously, so even *ex ante* value metrics may reflect an SSO's influence. To see whether "simultaneous" application and disclosure had a large impact on our results, we re-ran the analysis in Table 4.1 on the sub-sample of SSO patents (and matched controls) in the upper quartile of the application-to-disclosure lag distribution, which were declared 7.7 or more years after their application date. The results of this unreported analysis are quite similar to those in Table 4.1, suggesting that there is a substantial element of selection on observable (to the patent-holder) quality in the sample of SSO Patents.

4.2 Between SSO Comparisons

The remaining patent-level analyses will examine how difference in long-run outcomes (i.e. litigation and citation rates) vary according to SSOs, licensing commitments and disclosure timing. We continue to use the matched control patents as a way to adjust for differences in technology class, application and grant years. However, we now adopt the following regression framework

$$Y_{ij} = DECLARED_i \, \alpha_j + \beta_j + \lambda_y + \gamma_c$$

where Y_{ij} is an either a citation count or a litigation indicator for patent *i* in group *j*, and $DECLARED_i$ is an indicator variable that equals one if patent *i* was declared essential to an SSO. We focus on three groups (indexed by *j*): SSOs, Licensing Commitment Types, and application-to-disclosure lag categories. The coefficients λ_y and γ_c are a set of issue-year and technology class fixed effects, and the coefficients β_j measure differences in control patent outcomes across groups. We are interested in the vector of coefficients α_j that measures a group-specific difference between the SSO and matched control patents.

Table 4.2 shows estimates from a pair of regressions that allow the difference between SSO and control patents to vary by SSO.[21] The left half of the table shows coefficients and robust standard errors from a Poisson model of patent citations. The column labeled IRR reports an incident rate ratio (e^{β}), and can be interpreted as one plus the percentage change in citations relative to the SSO-specific matched controls (or in the case of Control patents, relative to the ANSI controls). The next two columns report a standard error and T test of the null hypothesis that the IRR equals one.

We observe in Table 4.2 that SSO Patents receive more citations than their matched controls at every SSO, with the possible exception of ITU. However, the size of the difference varies considerably across SSOs. The citation gap between declared essential and "average" patents is greatest for the Open Mobile Alliance, Internet Engineering Task Force and ATIS. The citations gap is notably smaller for ETSI, ANSI, and the ITU. This variation in the citation gap may reflect differences in either selectivity or the "treatment effect" of different SSOs or some combination of the two. However, the use of Control Patents, along with the technology-class and issue-year fixed effects, should capture any broad differences in citing patterns across technologies and time.[22]

The right half of Table 4.2 examines differences in the litigation rate of SSO and Control patents across SSOs. Because we estimate a linear probability model, each coefficient can be interpreted as the difference in the probability of litigation between patents declared to an SSO and the relevant set of matched controls. This outcome is expressed in percentage points, but is not an elasticity. Once again, we see considerable variation across SSOs. The difference in litigation probabilities between Control and SSO Patents is largest at ANSI, ATIS, ISO/IEC and OMA, where there is a 12 percentage point or more increase in litigation. This gap is smaller at ETSI, IETF, ITU and the OTHER category. Part of the explanation for the smaller "gap" at ETSI and IETF is the higher rate of litigation among matched controls for these SSOs.

[21] When a patent is declared essential to more than one SSO, we assign it the one where it was first declared.
[22] It is interesting to note differences in the citation rate of the matched control patents across SSOs. The IETF and OMA were the only SSOs with a control sample cited more frequently than the ANSI controls. The only SSO whose controls were statistically different from ANSI's at the 5 percent level was the ITU.

While one might have expected the estimated citations and litigation "effects" to co-vary positively across SSOs, Table 4.2 does not show any obvious relationships. For example, ANSI has the largest litigation gap and among the lowest in citations, while the patents declared to IETF are cited at a very high rate relative to their controls, and have one of the smaller litigation gaps. This may say something about the relative efficacy of alternative disclosure policies. However, we remain cautious about placing a causal interpretation on any of these comparisons. In particular, all of the measured "effects" could be explained by unobserved differences in technology or the types of firm participating in different SSOs. Moreover, we have no way of knowing the citation or litigation rates for patents declared under a blanket disclosure, and firms may well view the choice between a blanket and specific declarations strategically.

4.3 Licensing Commitments

While the vast majority of declarations in our data provide a FRAND licensing commitment, we do observe several alternatives in our sample of declared essential patents. Table 4.3 presents results from a pair of regressions that examine citation and litigation rates for patents initially declared under alternative licensing commitments.

For this analysis, we grouped patents into three broad categories, based on licensing commitment in their initial disclosure. The largest category (FRAND) contained 5,433 patents. The second category was "RF" which includes royalty free pledges and non-assertion covenants, and contains 318 patents. The final category (OTHER) contains all other types of declarations, e.g. licenses offered under specific terms or refusals to license, and contains 358 patents. We estimate the same regression model described above, but letting the group variable (*j*) index alternative licensing commitments as opposed to different SSOs. The results of this analysis are presented in Table 4.3

The left side of Table 4.3 compares citation rates for patents declared under different licensing commitments to their matched controls. Interestingly, we see that RF patents

had the largest increase in citations, even though the matched controls for those patents were cited at the highest rate. A Wald Test strongly rejects the null hypothesis that the coefficient on the SSO-FRAND and SSO-RF dummies are equal. There is no evidence that the SSO Patents in the OTHER category are cited at a statistically different rate from their FRAND counterparts.

The right half of Table 4.3 examines litigation rates by the type of licensing commitment. Once again, the FRAND and OTHER categories are quite similar, with both groups of SSO Patents litigated at a significantly higher rate than their matched controls ($p<0.05$). However, patents declared under a RF commitment are litigated significantly less often than those in the royalty bearing categories. In particular, the 2.3 percentage point difference in litigation rates between SSO-RF patents and their matched controls is less significant ($p=0.07$), and a the model rejects the hypothesis that the SSO-FRAND and SSO-RF patents have the same increase in litigation relative to their respective controls. While the 3.0 percentage points difference between these two groups may sound small, it represents a 60 percent drop in the per-patent probability of litigation, given a baseline litigation rate of roughly 5 percent.

The fact the royalty free patents are less likely to be litigated may not be surprising: there is little incentive to sue if a patent can be freely infringed (though defensive suspension provisions may explain why these patents are still more likely to be litigated than their matched controls).[23] However, the larger citation increase for RF patents is somewhat provocative, as it suggests a greater willingness to "build on" royalty free technology (as long as one is prepared to accept that relatively common interpretation of patent citations).

4.4 Disclosure Timing

[23] Note that even tough a patent may be offered license free when implemented in the context of a specific standard, the owner my ask monetary compensation fort hat patent if used otherwise. If that results in litigation it would be recorded in our database.

Our final patent-level analyses examine how citation and litigation outcomes vary with disclosure timing. Ideally, we would measure the timing of initial IP disclosure relative to the dates of key technical decisions for a particular standard. Unfortunately, we do not have that information. As an alternative measure of disclosure timing, we use the gap between patent application and declaration date. Patents that are declared essential immediately after application (and often well before they issue) are likely, though not certainly, motivated by the ongoing standards process. Patents that are declared long after applied for are more likely to cover technologies whose relationship to a proposed standard only became apparent over time. Thus, we view the application-to-declaration lag as a noisy estimate of our "ideal" timing measure.

Figure 4.1 shows the histogram of the time-lag between application and formal declaration (left panel) and between grant and formal declaration (right panel). The two histograms show that most declared essential patents are disclosed between zero and ten years after the application is filed, with a substantial peak in disclosures just after the patent issues. The small number of patents declared essential *before* their application date are primarily US family members of declared essential EPO patents with an earlier priority date. The second histogram shows a large peak just after declared essential patent is granted. We suspect this is driven by patent applications filed before 1999 (roughly half of our sample), since under US law these applications could remain secret until a patent was granted, and firms rarely disclosed unpublished applications except as part of a blanket declaration.

The left half of Table 4.4 shows that the application-to-disclosure lag has a strong positive association with citation rates. Patents declared essential shortly after an application is filed receive fewer cites (relative to a set of matched controls) than patents declared essential 8 or more years after application. This finding suggests that "selection on quality" is stronger when SSOs discover older patents that cover an attractive approach to some problem. When disclosure occurs just after application, the citation gap between SSO and Control Patents is smaller, suggesting that when firms file patents and immediately submit the invention to an SSO, the underlying ideas are relatively less

important. Of course, this provocative interpretation rests on the maintained assumption that citations are a good proxy for patent value, which will not be true in every case.

The right panel in Table 4.4 examines the correlation between disclosure timing and litigation rates. We find that patents with a long lag between application and declaration to an SSO have a higher litigation rate (relative to their matched controls) than patents with a shorter lag. Once again, if we take litigation as a proxy for perceived patent value, this suggests that longer application-to-disclosure lags are correlated with better patents. An alternative, and perhaps more provocative, interpretation of this finding is that long-lags are associated with hold-up, since delays allow time for a standard to diffuse and for implementers to make substantial technology-specific investments. Unfortunately, we cannot evaluate the hold-up hypothesis without better information on standardization dates, implementation and the true essentiality of declared essential patents.

5. Conclusions

SSOs adopt IP disclosure and licensing policies to promote widespread diffusion of standards that may incorporate intellectual property rights. This paper provides an overview of disclosure policies, describes a new database containing information on declared essential IPRs, and illustrates some of the ways that these data can be used.

We find that the number of IP declarations in our sample of 13 major SSOs has been steadily accelerating for the last two decades, and explore a number of potential causes, including changes in IPR policies and their enforcement, increased patenting, greater demand for standards and the increasingly vertically dis-integrated structure of many ICT markets. While there has been substantial growth in the number of firms declaring patents, and the number of technology classes covered by declared essential IPR, we nevertheless find that IP disclosure is increasingly concentrated in a small number of technology classes associated with wireless communication, and that the majority of disclosures increasingly come from a small number of very active firms.

We find that the 5,771 declared essential US patents in our database score much higher than a set of "average" patents with similar age and technology profiles on a variety of indicators of patent value or technical significance. We also show that the difference between SSO Patents and their matched controls varies across SSOs, licensing commitments and disclosure timing. Notably, patents declared under a royalty-free licensing commitment were cited at twice the rate of controls, and were only half as likely to be asserted in a lawsuit. Patents declared to an SSO 7.7 or more years after application were cited more frequently and litigated more often than patents declared essential shortly after the application was filed.

As noted in the introduction, this paper offers a first look at a new data source. All of our results are descriptive, and many have several plausible interpretations. We hope others will soon use these data to study questions related to standard setting, intellectual property strategy and the economics of the ICT sector.

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TABLES

Table 2.1: Disclosure and licensing commitment policies

SSO	*General statement ('blanket')*	*Specific patent statement*	*Allowed licensing commitments*	*Explicitly allowed licensing commitment options*	*Scope of the licensing commitment*
ANSI	Not specified	Not specified	RF; FRAND; non-assertion		Not specified
ATIS	Allowed	Allowed	RF; FRAND	- Reciprocity - RF-reciprocity (3)	A specified ATIS Forum, an ATIS Committee, an ATIS Document OR only the disclosed patents (at the choice of the declarant)
Broadband Forum	Required	'Desired but not required'	Reciprocal RF Reciprocal FRAND		A BF Technical Report (TR) A BF Working Text (WT)
CEN	Required	Optional (5)	RF; FRAND	- Reciprocity - RF-reciprocity (3)	A CEN Deliverable
CENELEC	Required	Optional (5)	RF; FRAND	- Reciprocity - RF-reciprocity (3)	A CENELEC Deliverable
ETSI	Optional since 2009 (4)	Required	FRAND	- Reciprocity - For own contributions only (in case of GD) (2)	Specific statement: Disclosed patents, with some exceptions (4). General statement: A specified deliverable (6) or a specified 'ETSI Project or any ETSI Project
IEC (1)	Required	Optional but encouraged (5)	RF; FRAND	- Reciprocity - RC-reciprocity (3)	An IEC deliverable
IEEE	Allowed	Allowed	RF; FRAND; non-enforcement	- Licensing fees (ex-ante) - Sample of licensing contract	A specified IEEE 'Standard or a IEEE 'Project' OR only the disclosed patents (at the choice of the declarant)
IETF	Not allowed (unless when accompanied by an RF commitment)	Required (except when accompanied by an RF commitment)	RF; FRAND; non-assert	Any licensing information	The disclosed patents, or, in case of a RF blanket statement, a specific of any IETF contribution (8)
ISO (1)	Required	Optional but encouraged (5)	RF; FRAND	- Reciprocity - RF-reciprocity (3)	An ISO Deliverable
ITU	Required	Optional but encouraged (5)	RF; FRAND	- Reciprocity - RF-reciprocity (3)	An ITU Recommendation
OMA	Not allowed	Required	Reciprocal FRAND		An (Draft) Technical Specification
TIA	Allowed	Allowed	RF; FRAND	- Reciprocity	*General Statement*: A 'Designated Document Number' or 'Designated Committee Documents' or 'All TIA Documents'. *Specific statement*: only the disclosed patents (7) OR the same categories in the general statement (at the choice of the declarant)

Notes: (1). Includes JTC-1 activities. (2) For General IPR Licensing Declarations, ETSI allows the declarant to restrict its commitment only to IPRs contained in its own technical contributions. (3) These bodies explicitly provide the option for declarants to commit themselves to RF, yet preserve the freedom to collect FRAND fees for organizations that do not license out their own patents at RF. (4) Prior to 2009, no such option explicitly existed, although some declarants did make such statements by submitting specific patent statements (now known as ISLD) with empty patent fields formulating a blanket in an additional notes text. (5) Required in the case a refusal to license is submitted to ITU, and 'strongly desired' in that case by ISO, IEC, CEN and CENELEC. (6) The main deliverable of ETSI include European Standards (EN), ETSI Standards (ES) and ETSI Technical Specifications (TS). (7) There is a requirement that the list of disclosed patents must include ALL essential patents for that standard. (8) There is an option to limit to standards-track IETF documents.

Table 3.1. Declaration Summary Statistics by SSO

SSO	Total Declarations	Blanket Declarations	Specific IPR (US & EPO)	Unique IPRs (US & EPO)	INPADOC families
ANSI	366	221	304	211	173
ATIS	77	46	212	157	104
BBF	23	6	74	34	16
CEN	5	0	21	5	4
CENELEC	11	8	4	4	4
ETSI	701	47	10,409	6,375	4,051
IEC	166	90	139	129	80
IEC - JTC1	196	101	619	337	168
IEEE	655	440	859	532	394
IETF	890	363	2389	579	433
ISO	134	82	127	59	36
ISO - JTC1	385	221	757	145	105
ITU	1,032	631	1,120	583	462
OMA	100	0	573	457	323
TIA	263	251	37	28	22
Total	5,004	2,507	17,644	9,635	6,375[a]

Notes: Blanket declarations refer to those that list no specific IPR. Specific IPR is defined as a US or EPO patent or patent application number (which may be counted more than once). INPADOC families are groups of IPR that share a common priority application

Table 3.2. Disclosure Size Distribution

Declaration Size Category	Frequency	Share of Declarations	ETSI Share	Avg. Year	US & EPO patents / applications	Share of patents / applications
True blanket	2522	50.4	1.9	2002.6	0	0
0	893	17.8	21.1	2004.7	0	0
1	731	14.6	19.4	2003.9	731	0.08
2 to 4	495	9.9	26.3	2003.7	1,285	0.13
5 to 20	275	5.5	44.0	2005.0	2475	0.26
21 to 50	62	1.2	75.8	2006.5	1799	0.19
More than 50	26	0.5	100.0	2005.3	3345	0.35
Total	5004				9635	

Notes: A "true blanket" declaration makes a FRAND licensing commitment for all potentially essential IPR, whereas Disclosure Size of zero implies a declaration with no patents listed and no FRAND commitment.

Table 3.3. Firm Concentration

	Total Firms	INPADOC families	Most Active Firms	Share	C4	HHI
1980-1990	28	92	AT&T	18%	0.50	0.08
			Nortel Networks	12%		
			3M	11%		
			Eastman Kodak	9%		
			OTHER	50%		
1991-1995	58	307	IBM	19%	0.51	0.09
			AT&T	15%		
			Motorola	13%		
			Apple	4%		
			OTHER	49%		
1996-2000	134	1,083	France Telecom	13%	0.36	0.05
			Nokia	11%		
			Ericsson	8%		
			Alcatel	4%		
			OTHER	64%		
2001-2005	193	5,044	Nokia	15%	0.44	0.06
			Motorola	11%		
			Qualcomm	9%		
			InterDigital	9%		
			OTHER	56%		
2006-2011	221	11,041	Qualcomm	19%	0.52	0.08
			Motorola	13%		
			InterDigital	10%		
			Nokia	9%		
			OTHER	48%		
Total	634	17,567				

Notes: The Herfindahl index (HHI) is a sum of squared shares of all organizations making one or more declarations during the relevant time period.

Table 3.4. Technology Class Concentration

	Total IPC classes	Top IPC classes		Share	C4	HHI
1980-1990	33	H04L	Transmission of digital information, e.g. telegraphic communication	17%	0.50	0.08
		G11B	Information storage based on relative movement between record carrier and transducer	13%		
		H04B	Transmission	10%		
		B23K	Soldering or unsoldering; welding; cladding or plating by soldering or welding; cutting by applying heat locally, e.g. flame cutting; working by laser beam	10%		
		OTHER		50%		
1991-1995	44	H04N	Pictorial communication, e.g. television	25%	0.57	0.12
		H04L	Transmission of digital information, e.g. telegraphic communication	17%		
		H04W	Wireless communication networks	8%		
		H03M	Coding, decoding or code conversion, in general	7%		
		OTHER		43%		
1996-2000	78	H04L	Transmission of digital information, e.g. telegraphic communication	21%	0.61	0.11
		H04B	Transmission	15%		
		H04W	Wireless communication networks	15%		
		H04N	Pictorial communication, e.g. television	11%		
		OTHER		39%		
2001-2005	138	H04L	Transmission of digital information, e.g. telegraphic communication	24%	0.70	0.14
		H04B	Transmission	20%		
		H04W	Wireless communication networks	18%		
		H04J	Multiplex communication	8%		
		OTHER		30%		
2006-2011	168	H04L	Transmission of digital information, e.g. telegraphic communication	26%	0.71	0.16
		H04W	Wireless communication networks	24%		
		H04B	Transmission	14%		
		H04J	Multiplex communication	7%		
		OTHER		29%		

Notes: The Herfindahl index (HHI) is a sum of squared shares of all technology classes containing one or more declared essential US or EPO patent during the relevant time period.

Table 3.5. Disclosure Summary Statistics by Business Model Category

Organizational Category	Examples	Claimants (Percent)	Declarations (Percent)	Blankets (Percent)	Avg. Disclosure Size	INPADOC (Percent)
Pure upstream knowledge developer or patent holding company (excl. universities)	Dolby, Digital Theatre Systems, 'IPR licensing'	8.46	3.62	4.44	15.4	10.57
Universities / public research institutes / states	University of Cherbrooke, Fraunhofer Gesellschaft	11.48	3.99	4.74	0.9	0.72
Components (incl. semiconductors)	Qualcomm, Intel, Harting (connectors)	12.69	12.76	15.40	7.4	17.74
Software and software-based services	Microsoft, Sun	4.83	5.71	5.93	2.8	3.66
Equipment suppliers, product vendors, system integrators	Ericsson, Nokia, Hewlett-Packard, Dell	40.79	59.99	57.43	4.0	60.81
Service providers (telecommunications, radio, television, etc.)	Vodafone, BBC	9.67	11.20	9.32	1.8	5.57
SSOs, fora and consortia, technology promotors	Konnex Association, ETSI	12.10	0.32	0.40	1.0	0.06
Individual patent owner		7.55	0.81	0.60	1.0	0.24
Measurement and instruments, test systems	Tektronix, Rohde & Schwarz	1.51	0.22	0.05	1.5	0.14
Total Counts		331	4061	n/a	n/a	8721

Table 3.6. SSO Participation by Business Model Category

Organizational Category	ANSI	ETSI	IEC	IEC - JTC1	IEEE	IETF	ISO - JTC1	ITU	TIA
Pure upstream knowledge developer or patent holding company (excl. universities)	2	4	2	3	4	4	5	4	2
Universities / public research institutes / states	1	2	3	7	5	2	10	7	na
Components (incl. semiconductors)	12	14	9	21	18	4	16	10	26
Software and software-based services	11	2	1	8	5	10	6	5	na
Equipment suppliers, product vendors, system integrators	52	67	63	54	58	68	53	54	64
Service providers (telecommunications, radio, television, etc.)	13	11	6	5	8	9	8	19	7
SSOs, fora and consortia, technology promotors	na	na	5	na	na	na	0	0	0
Individual patent owner	2	na	2	na	2	2	1	0	na
Measurement and instruments, test systems	0	0	2	na	0	0	0	0	na
Total Declarations	248	657	99	168	469	773	304	866	231
Herfindahl Index for Declarations	0.31	0.49	0.41	0.35	0.38	0.49	0.33	0.35	0.48

Table 4.1: Comparison of SSO and Matched Control Patents

	SSO Patents	**Control Patents**	**T-stat**
Litigated	0.07	0.02	14.26
Forward US Patent Citations	24.76	12.72	16.24
Forward Intl Patent Citations	4.61	9.34	18.05
Family Size (Countries)	7.69	3.64	45.89
Claims	12.94	10.49	7.87
Backward Patent Citations	20.92	16.82	6.59
Backward Non-patent Citations	6.97	4.68	5.07
Application Year	1998.8	1998.8	0.06
Issue Year	2002.2	2002.2	0.01
Observations	5771	5771	

Notes: SSO Patents are all declared essential US patents or DOC-DB family members of declared essential EP patents. The Control patents are a one-to-one matched random sample of patents whose joint distribution of primary (3 digit) technology classes, application years and issue years is identical to the SSO patents. See text for additional details on matching.

Table 4.2: Citation and Litigation Outcomes by SSO

	Citations Poisson			Litigation OLS		
	IRR	**S.E.**	**T-Stat**	**Coeff**	**S.E.**	**T-Stat**
SSO Interactions (α_j)						
ANSI	1.69	0.24	3.67	0.13	0.03	5.05
ATIS	2.22	0.49	3.59	0.12	0.03	3.84
ETSI	1.58	0.20	3.62	0.08	0.01	6.78
IEEE	1.92	0.24	5.11	0.10	0.02	6.27
IETF	2.85	0.40	7.49	0.07	0.01	5.06
ISO/IEC/JTC1	1.83	0.25	4.45	0.12	0.02	6.45
ITU	1.18	0.15	1.29	0.07	0.01	5.05
OMA	3.83	0.61	8.40	0.12	0.02	5.76
OTHER	1.88	0.38	3.10	0.06	0.03	2.03
Control Coefficients (β_j)						
ANSI	1.00	na	na	0.00	na	na
ATIS	0.72	0.17	-1.35	0.03	0.01	1.93
ETSI	0.87	0.11	-1.12	0.04	0.01	3.70
IEEE	0.99	0.14	-0.04	0.03	0.01	2.73
IETF	1.15	0.19	0.82	0.04	0.01	3.44
ISO/IEC/JTC1	0.77	0.11	-1.81	0.02	0.01	2.01
ITU	0.69	0.09	-2.73	0.01	0.01	0.81
OMA	1.24	0.23	1.16	0.03	0.01	2.45
OTHER	0.81	0.18	-0.93	0.03	0.02	1.52
Issue-Year Effects		Yes			Yes	
Technology Class		Yes			Yes	
Observations		11540			11540	

Notes: Standard errors are robust.

Table 4.3: Citation and Litigation Outcomes by Licensing Commitment

	Citations Poisson			Litigation OLS		
	Coeff	**S.E.**	**T-Stat**	**Coeff**	**S.E.**	**T-Stat**
SSO Interactions (α_j)						
FRAND	1.93	0.06	19.67	0.053	0.004	14.05
RF	2.94	0.35	9.03	0.023	0.013	1.81
OTHER	2.27	0.25	7.37	0.046	0.020	2.29
Control Coefficients (β_j)						
FRAND	1.00	na	na	0.000	na	na
RF	1.29	0.41	0.79	-0.002	0.003	-0.64
OTHER	1.05	0.14	0.39	-0.010	0.008	-1.26
Issue-Year Effects		Yes			Yes	
Technology Class		Yes			Yes	
Observations		11,540			11,540	
SSO-FRAND		5,433			5,433	
SSORF		318			318	
SSO-OTHER		358			358	

Notes: Standard errors are robust. RF commitments include non-assertion covenants.

Table 4.4: Citation and Litigation Outcomes by Disclosure Timing

	Citations Poisson			Litigation OLS		
	Coeff.	**Std Err**	**T-stat**	**Coeff.**	**Std Err**	**T-stat**
SSO Interactions (α_j)						
Lag < 2.8 yrs	1.34	0.10	3.87	0.04	0.01	5.91
(2.8, 4.9]	1.62	0.12	6.68	0.04	0.01	5.60
(4.9, 7.7]	1.79	0.12	8.75	0.03	0.01	4.32
Lag >7.7 yrs	2.07	0.15	10.32	0.06	0.01	7.55
Control Coefficients (β_j)						
Lag < 2.8 yrs	1.00	na	na	0.00	na	na
(2.8, 4.9]	0.93	0.07	-0.97	-0.01	0.00	-2.39
(4.9, 7.7]	0.94	0.07	-0.76	-0.01	0.00	-2.84
Lag >7.7 yrs	0.88	0.06	-1.74	-0.02	0.01	-3.28
Issue-Year Effects		Yes			Yes	
Technology Class		Yes			Yes	
Observations		11540			11540	

Notes: Standard errors are robust. Lag measured in days from US patent application to first declaration date. Cutoffs were selected by using quartles of the application-to-disclosure lag distribution.

FIGURES

Figure 2.1: Two Disclosure Timing Scenarios

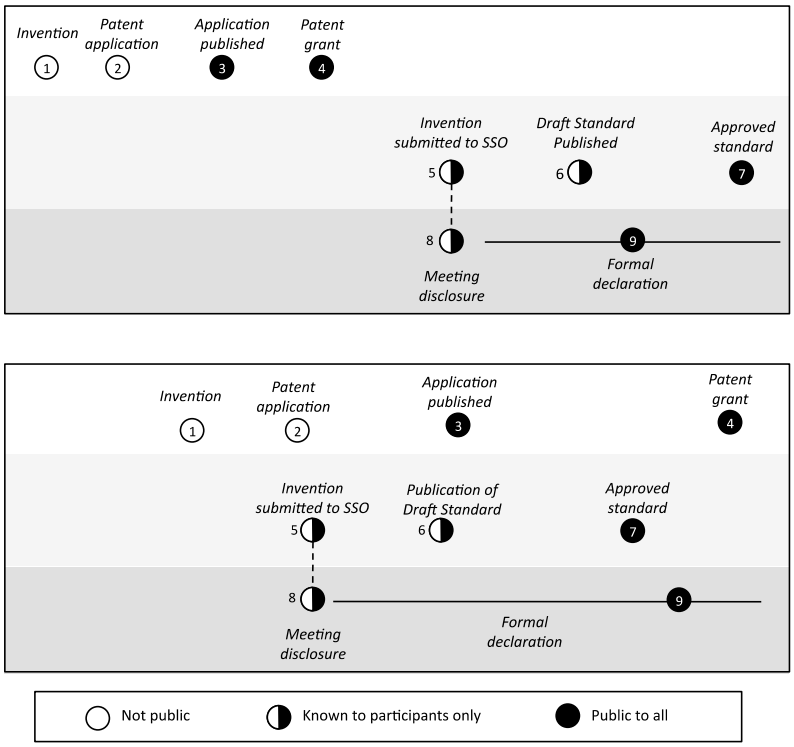


Figure 3.1. Annual IP declarations

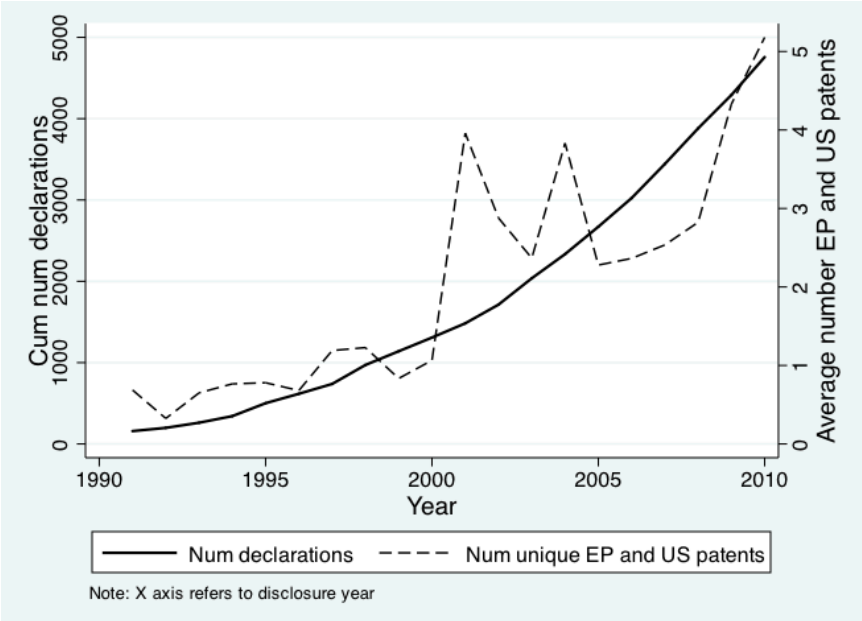


Figure 3.2. Declarations by SSO-Year

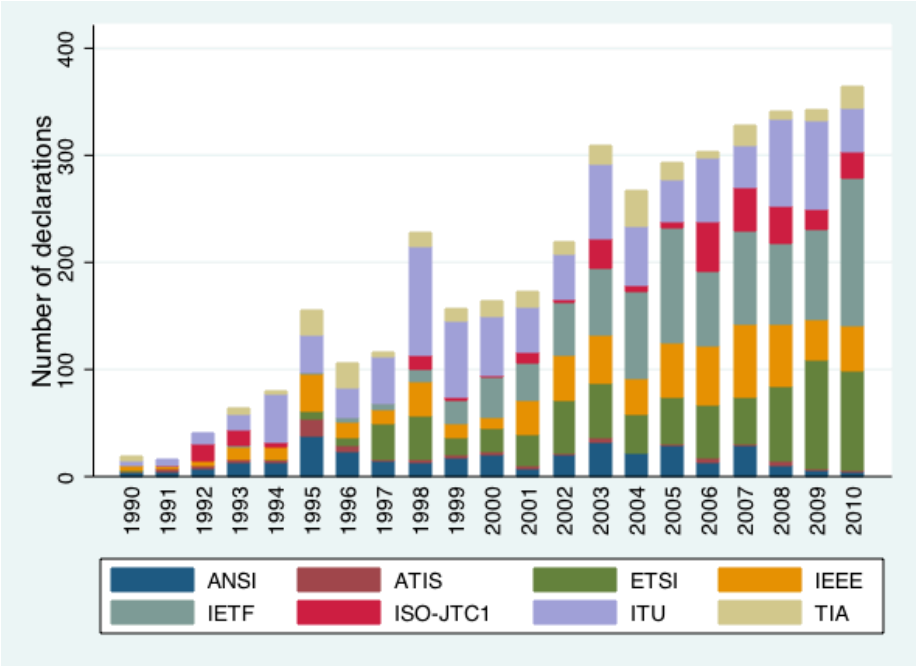


Figure 3.3 Disclosure to Multiple SSOs

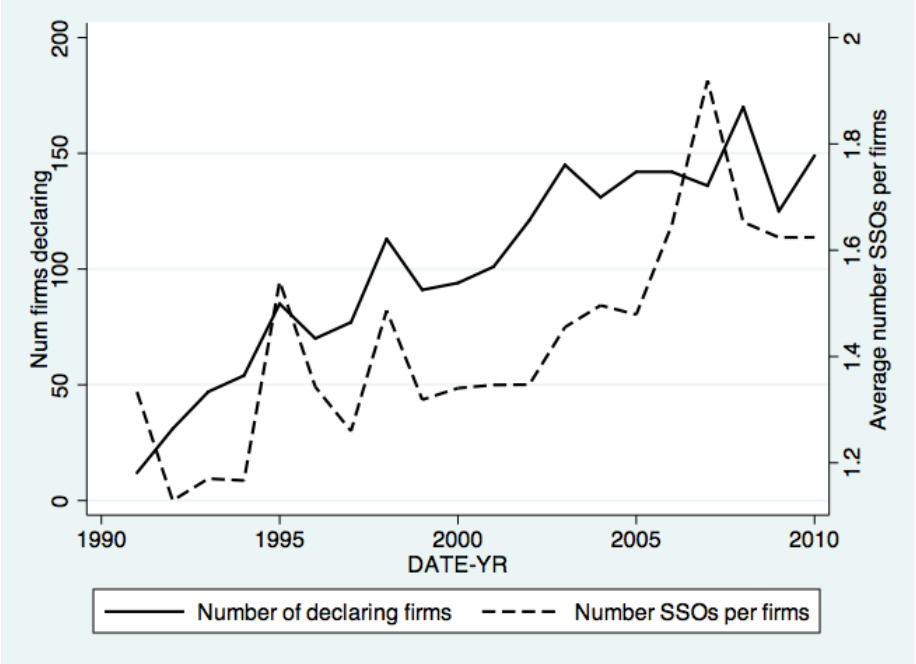


Figure 3.4 Geographic distribution of business model categories

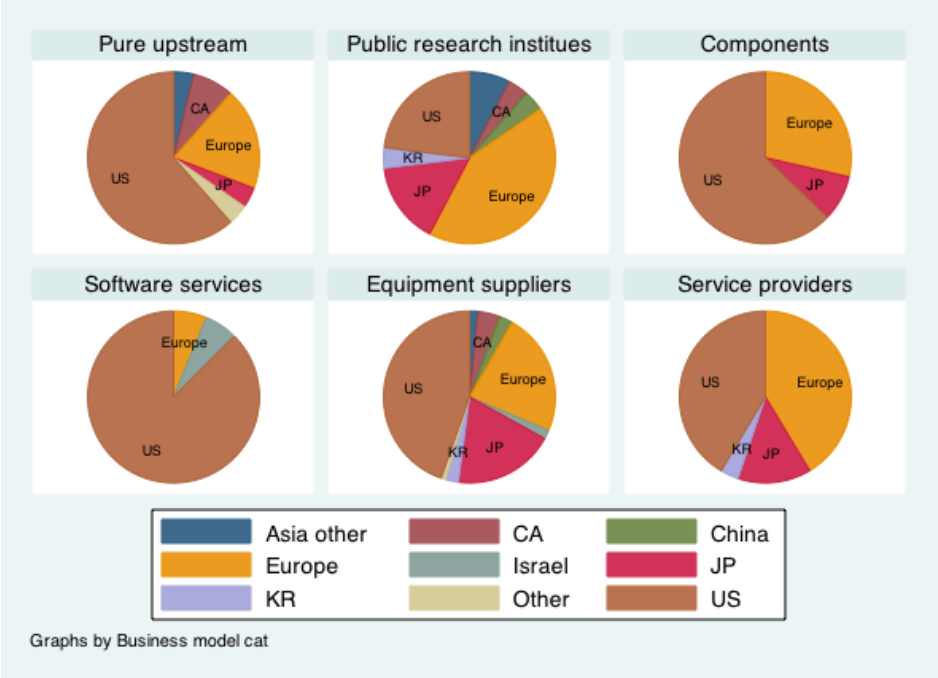
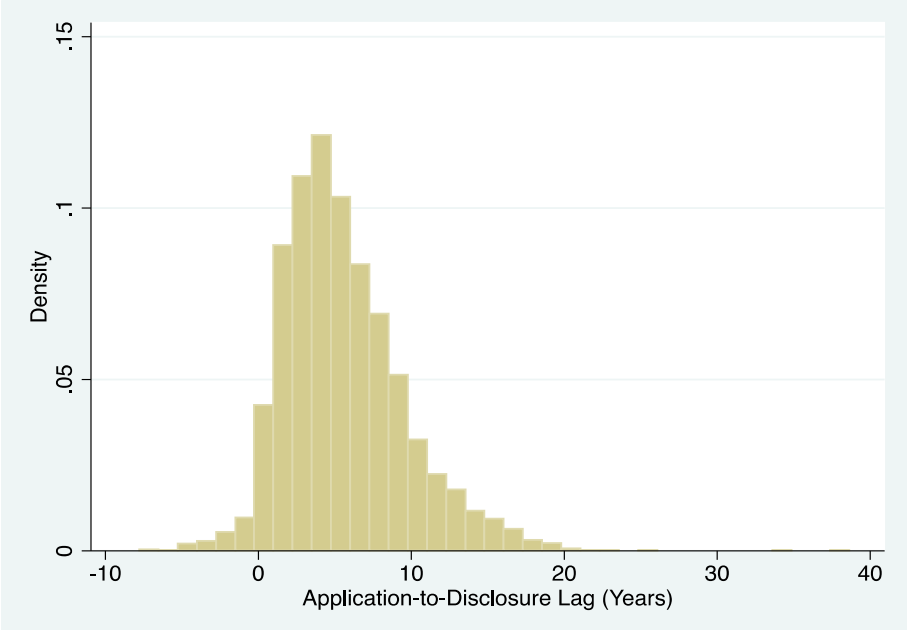
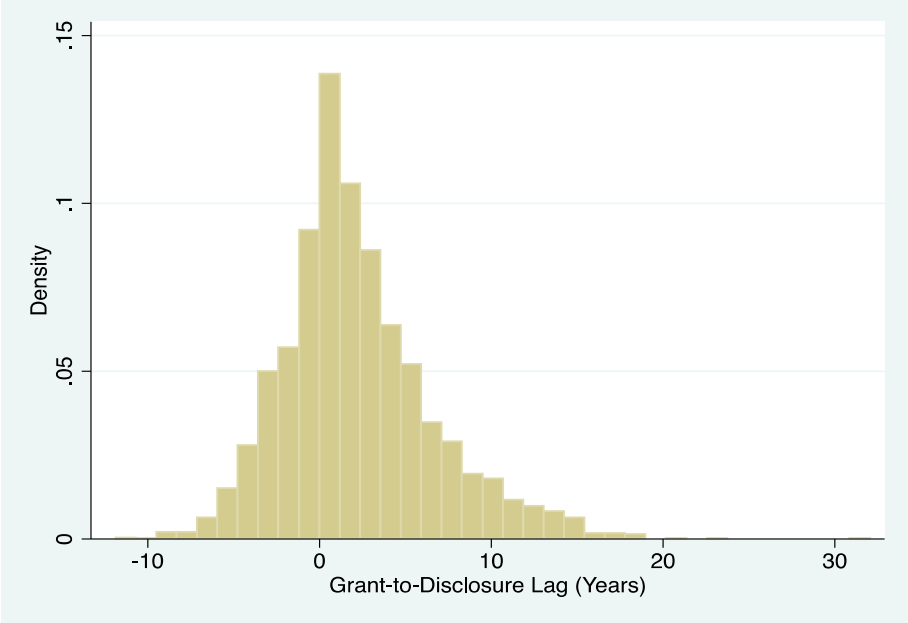


Figure 4.1 Disclosure Timing




Density
0
.05
.1
.15
-10
0
10
20
30
Grant-to-Disclosure Lag (Years)

Appendix A: The Open Essential IPR Disclosure Database (OEIDD)

The database we compiled - and make freely available to any interested party - contains all the IPR disclosures and commitment statements that were made public by IPR owners at 13 important standards bodies. The source data typically – but not necessarily - includes the following information: the patent owner[24], the date of the statement, the standard or standardization activity for which the patent(s) are deemed essential, the licensing commitment the patent owner is making, and the identity of the patent(s) in question.

During our effort, we took the original statements at these standards bodies - as available in March 2011 - as a starting point, and we subsequently (1) cleaned, (2) harmonized, (3) matched, and (4) complemented this data. The *cleaning* entails that information such as patent numbers, patent authorities, standards or standardization activities is examined, completed, corrected where necessary, and stored in a standardized format. The *harmonization* concerns the consistent coding of information across and within the data from the various SSO, such as firm[25] names and standardization activities. The *matching* means that each disclosed patent identity at either the US Patent and Trademark Office (USPTO) or the European Patent Office (EPO) is matched with data from a reference patent database, which is the OECD/EPO PATSTAT[26] database, and complemented with relevant metadata. This metadata includes he date of the patent application, data on the first publication of the application, and information on the first publication of the patent, as well as the DOCDB and INPADOC family identities. The patent family information is particularly useful as it allows the user of the database to correct for the rather substantial degree of overlap that is present in the source data. Finally, we complemented the data with information about the patent owner, such as its home region (typically the world region in which the headquarters are located), and its business model.

The Open Essential IPR Disclosure Database has a relational structure as shown in Figure xx. Below will shortly elaborate on the different tables and their content; more detailed information is made available as part of the database.

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[24] While the declarant is typically also the owner of the disclosed patents, there are few SSOs that also allow for third-party disclosures. Such disclosures, however, also name the presumed patent owner. In our database, third-party disclosures can be recognized by a specific flag.

[25] In this paper we will use the name 'firm' for IPR owner, although we acknowledge that there are also other types of owners such as universities, and public research laboratories.

[26] EPO Worldwide Patent Statistical Database (also known as EPO PATSTAT) has been specifically developed for use by government/intergovernmental organizations and academic institutions. It has been developed by the European Patent Office, in close cooperation with the OECD. With over 70 million records and with a file size of over 130 GBytes, it is one of the most extensive database with 'raw' patent data currently available. We used the September 2010 version of this database for our matching efforts.

Firstly, *Table 01, 'Declarations',* contains disclosure and/or commitment events. Such an event is defined as a declaration by specific firm, at a specific SSO, on a specific date. The declaration may disclose one or more identified patents, may include blankets, and typically provides information about the licensing commitments. A declaration may concern different standards or functionalities.

Figure A-1: Table Structure of Open Intellectual Property Disclosure Database

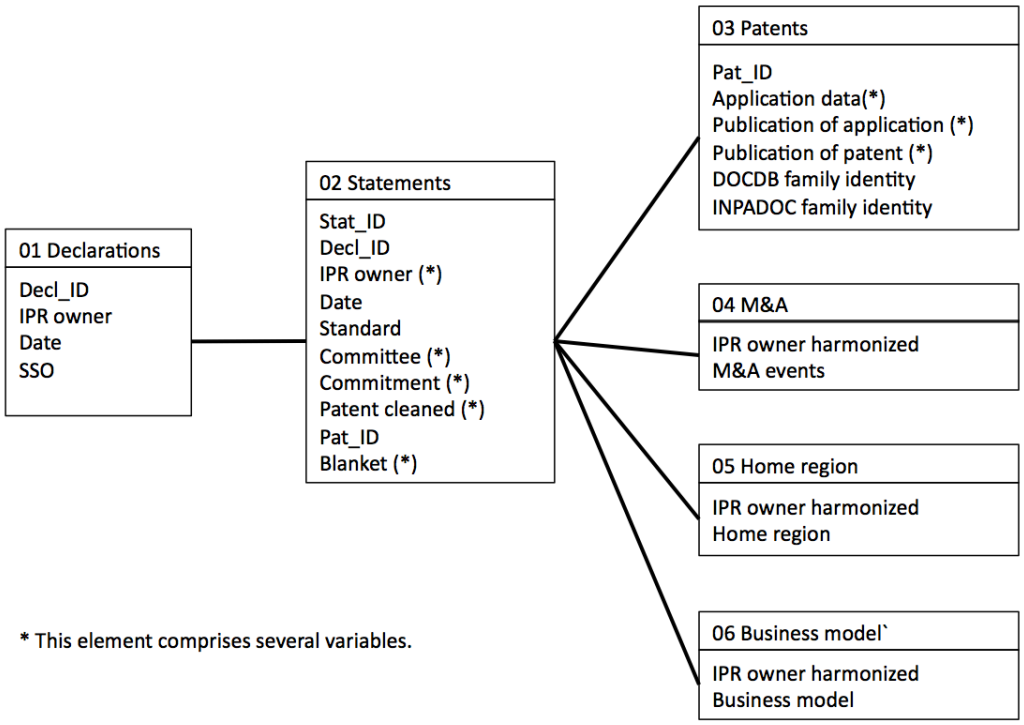

Table 2, 'Statements', is the core of the database and contains over 45,000 records that each represent a general or a specific disclosure (where each patent has its own record). The most important elements of this table are:

- The identity of the **IPR owner** as it appears on the original disclosure, as well as a newly-created harmonized name. This harmonization groups all the different (legal) names used by the same firm. In case of third party disclosures, this field contains the name of the presumed IPR owner, not that of the declarant.
- The **date** on which the statement was submitted.
- **Disclosure** information, such as whether a disclosure is general (i.e. no specific patent identities provided, aka a 'banket'), or specific. In case of a general disclosure, the scope is provided (i.e. the

standard or standardization activity to which the disclosure relates). If the disclosure is specific, the table provides the 'cleaned' patent identities provided by the declarant. This may a publication number of the patent, a publication number of the patent application, but may also be just a serial number for the patent applications – for instance if the application was not yet published by the patent office at the time of the disclosure. There is also a variable that assigns a specific ID to all patents that we were able to match in PATSTAT, and that provides the link to the patents table.
- The **standard or standardization activity** for which the disclosed IPR is believed to be essential. For some SSOs, the name of the standard is provided, other SSOs provide the name of the relevant standardization activity (which may be a Working Group, Sub Committee, Technical Committee, or a 'project'). For some bodies, both are provided.
- **Commitment** information, including the type of commitment made (e.g. FRAND or RF), as well as the scope of the commitment: is it limited to specific disclosed patents, or does it include all patents in a specified standard or standardization activity, or possibly even any activity by the SSO?

Table 3, 'Patents', provides extensive information on the disclosed USPTO and EPO patents we were able to locate in the PATSTAT database. Regardless on what patent identity was given in the disclosure, this table provides extensive information on the patent application (including serial number and date), on the first publication of the application (if any), and on the publication of the granted patent (if any). This publication data, for instance, allow for citation analysis, even if the original disclosure only offered serial numbers of patent applications. The table also provides INPADOC and DOCDB patent family identities, allowing the recognition of patents that protect a single invention.

The industries in which we find patents in standards have shown considerable dynamics. There have been a substantial number of mergers and acquisitions involving the companies that have disclosed essential IPR. *Table 4, 'M&A'* provides a list of 58 M&A events, including the year in which they took place. While this list might not be exhaustive, we believe it is quite complete. Combining this information with the harmonized IPR owner name provided in Table 2, the user can reconstruct IPR ownership at any desired point in time.

Table 5, 'Home region' provides information on the home base of the IPR owner (e.g. US, Europe, Japan). In principle, we base this on the location of the headquarter of the organization. The home region is provided for every IPR owner that has 4 or more records in the database.

Finally, *Table 6 'Business model'* indicates the prevalent business model of the various IPR owners. Among other categories, it differentiations between knowledge developers and patent holding companies (i.e. pure upstream models), universities and public laboratories, component suppliers

(incl. semiconductors), software companies, equipment suppliers (incl. product vendors, system integrators), and service providers (e.g. network operators, broadcasters). While our categories are not specifically designed only to cover the telecommunications and consumer electronics industries, we ensured that these fields are properly coded, because of their dominant presence in the database. While many firms combine different business models, we have chosen the predominant one, such as the one that is most key to the organization's overall revenues. An exception is the pure upstream companies: firms are only allocated to this category if they have *no* operating activities at all. Currently, the business model is provided for every IPR owner that has 7 or more records in the database.

Conditions of use, limitations

Our Open Essential IPR Disclosure Database is made available to any interested users for free. The only requirement is that any paper or report that uses this data includes a reference to this paper.

It is also important to be aware of inherent limitations of the source data we used. The most important ones are: (1) none of the SSOs requires that statements are updated when the situation changes. A patent may become non-essential of the granted patent is more narrow in scope than the patent application, or when the protected invention is eventually not incorporated in the standard. Such non-essential patents would still be present in the current database. (2) SSOs do not require notification of ownership changes (although some now request such information). If a patent is transferred, the database may still list the old owner - although the new owner may again disclose the patents. (3) not all SSOs require that specific patents are identified, so the database might not contain all patents that are actually essential. (4) For strategic reasons, patent owners might disclose patents that are actually not essential ('over disclosure') or fail to disclose essential patents ('under disclosure'). Although law cases have shown there can be legal penalties for both types of conduct. Several reports claim a very substantial degree of over disclosure for the WCDMA and for the LTE standard, but the actual findings of these reports are so different than at least one or possibly both must be very inaccurate.[27] (5) Non-members of an SSO have no obligations under the IPR policies whatsoever, so their statements might be missing.

Despite these inherence limitations, these disclosures are the most tangible manifestation of the increasingly important phenomenon of patents in standards.

[27] See Goodman & Myers (2005); Fairfield Resources International (2010); and Jefferies. (2011), as well as the commentary in Mallinson (2011).

Disclaimer. As a matter of disclaimer, we whish to note that since our data builds on self-declarations of patent owners, we cannot guarantee this data is complete or correct. Furthermore, though we have gone at great length to properly clean, harmonize, match and complement the data, we do not assume any responsibility for eventual errors.

Appendix B: Detailed Overview of SSO Intellectual Property Policies

The **European Telecommunications Standards Institute (ETSI)** is the recognized European standards body for telecommunications. It brought forth a number of very successful standards that were adopted all around the globe, including GSM, DECT, 3G WCDMA/UMTS, and 4G LTE.[28] It was one of the earliest SSOs to develop an IPR policy, in the early 1990s. It was under considerable pressure to do so because there were severe problems concerning IPR holders that refused to license all the implementers of the standard (see Bekkers et al, 2002). Its first formal policy was adopted in March 1993 but met considerable resistance from IPR owners. It was replaced by a new policy in 1994 (Iversen, 1999 and Bekkers, 2001). This new policy is still in place (with minor updates) and has become the blueprint for policies at many other SSOs. In essence, it is a F/RAND policy that requires all members to disclose any IPR they own that they believe to be essential. They should use their reasonable endeavors to identify such IPR. In particular, members that propose to include certain technologies in a standard are required draw the attention of ETSI to any its IPR which might be essential should their proposal be adopted. The second important element is that members are also (strongly) requested for their disclosed IPR to indicate that they commit themselves to the F/RAND licensing. If any organization refuses to do so, the IPR policy sets procedures on how ETSI should proceed, including options to invent-around, or to halt work on the standard.

At ETSI, the formal disclosure and indication of commitments is done with a template(recently labeled "IPR Information Statement and Licensing Declaration - ISLD") in which a organization discloses the specific IPRs it believes to be essential, and indicates whether it is willing to grant licenses under F/RAND licensing terms (as defined in the 'Annex 6' of the ETSI Rules and Procedures[29]). While this template specifically relates to the IPR (patent numbers etc.) as provided by the declarant, we observe that there are also companies that submitted such statements without supplying any specific patent identities, and instead added a written note that they are willing to

[28] 3G WCDMA/UMTS, and 4G LTE were standardized in cooperation with other 3GPP partners.
[29] "ETSI Rules of Procedure, 8 April 2009" (Version 25), retrieved on 17 November 2011 from http://www.etsi.org/WebSite/document/Legal/ETSI_IPR-Policy.pdf.

license any of their essential IPR in a given area (usually a project, or any activity within ETSI). In our interpretation we consider this to be a blanket statement, even though the (original) ETSI IPR policies and the associated templates did not explicitly allow such a statement. We also observe that, at some point in time, firms started to add written notes that their F/RAND commitment was subject to reciprocity. Later, this option was formalized by explicitly listing this option in later versions of the template.

In 2009, ETSI addressed this issue by introducing a second type of statement, called the 'General IPR licensing declaration - GD', in which an organization can commit itself to license all its essential IPR (or, at choice, all its essential IPR that is part of its own technical contributions) for a given ETSI standard, a given ETSI project, or for any ETSI project – without listing specific patent identities. In our terminology, these could be considered as 'blanket statements'. However, according to ETSI, this templateis only to be used *in 'cases where you do not have all the detailed knowledge of the essentiality of your IPR yet, but you want, nonetheless, to tell ETSI about your preparedness to grant licenses'*.[30] However, it does not remove the obligation for members to declare specific essential IPRs to ETSI[31], and thus this statement has to be followed later by a specific statement as described above. In this sense, this statement is only 'temporary' and differs from the ETSI blanket statements referred to above, which members appear to have submitted *instead* of specific statements.

While ETSI allows for voluntary ex-ante declaration of most restrictive licensing terms[32], no member has decided to use this option as of November 2011. Some other specificities is that the current ETSI IPR policy specifies that for patent families, it is sufficient to declare only one single family member (although one may voluntary declare other members), yet that the licensing commitment by default applies to any patent family member – unless explicitly stated otherwise by the owner.

All the above information statements are made public by ETSI in a Special Report (known as SR 000 314). Later on, this information became also available via an on-line web interface, and per 2011 ETSI introduced a total overhaul of its database, known as the 'DARE' project, which also resulted in a fully renewed online database.

For our purposes, we used the ETSI on-line database as of March 2, 2011. The statements from the new 'general' ('temporary') statements were only made public after we collected and processed our

[30] "Guidelines on how to declare an essential IPR and how to make Licensing Declarations to ETSI", retrieved on 17 November 2011 from http://www.etsi.org/WebSite/AboutETSI/IPRsInETSI/Guidelines_IPR_Declarations.aspx.
[31] Clause 2.1.3 in the "ETSI Guide on IPRs, 27 November 2008", retrieved on 17 November 2011 from http://etsi.org/WebSite/document/Legal/ETSI_Guide_on_IPRs.pdf.
[32] "Ex ante disclosures of licensing terms", retrieved on 17 November 2011 from http://etsi.org/WebSite/AboutETSI/IPRsInETSI/Ex-ante.aspx

data, therefor not part of our database. At the time we retrieved the data, ETSI did not yet allocate any ID information (e.g. record number) to their data, even though we are talking about over 28,000 records.

The International Organization for Standardization (ISO) and the **International Electrotechnical Commission (IEC)** are SSOs that aim to develop international standards and are formally recognized by virtually all countries worldwide. Whereas ISO has a very wide scope of activities, IEC specifically focuses on standards with an electro-technical nature. The **International Telecommunication Union (ITU)**[33] is an UN body and focuses on the standardization of telecommunications (but also has significant activities outside the field of standardization). These three organizations have a common IPR policy. This is particularly practical since a substantial number of standardization activities is performed by ISO and IEC jointly in their Joint Technical Committee 1 (JTC-1). While there are small differences between the policies of the three bodies, there is no need to take these into account in the context of this paper. Cornerstones of this common policy are (1) any party participating in the work of these SSOs should, from the outset, draw the attention to any known patent or to any known pending patent application, either their own or of other organizations, (2) if a standard ('Recommendation' or 'Deliverable') is adopted, then essential patent owners may chose one of three options: (a) commit itself to royalty free licenses, (b) commit itself to F/RAND licenses, or (c) neither of these. In the latter case, the ultimate standard will not include provisions depending on the patent.[34]

For their statements, organizations are required to use the appropriate "Patent Statement and Licensing Declaration" template, and may not include additional provisions, conditions, or any other exclusion clauses in excess of what is provided for each case in the corresponding boxes of the template. This effectively means that the template dictates the type of statements that can be made.

The commitments made to these SSOs by definition relate to a specific standard (i.e. a 'Recommendation' at ITU and a 'Deliverable' at the other bodies), not just to the disclosed patents (if any).

The **European Committee for Standardization (CEN)** and European **Committee for Electrotechnical Standardization** (**CENELEC)** are the European counterparts of ISO and IEC respectively. They always have had a joint IPR policy, and in 2009, they decided to adopt the common IPR policy that was already in place at ISO, IEC, ITU-T, and ITU-R. This new policy, defined in 'Guide 8',

[33] In the context of this report, 'ITU' refers to both ITU-T and ITU-R.

[34] Common Patent Policy for ITU-T/ITU-R/ISO/IEC. Retrieved on 17 November 2011 from http://www.itu.int/en/ITU-T/ipr/Pages/policy.aspx.

replaces the earlier policy that was defined in the older so-called 'Memorandum 8'. The total number of patent statements received by these organizations is very low, less than two dozen as of November 2011. While some of these statements, judging on their date, have been made under the 'new' regime, the information provided by CEN/Cenelec does not provide all the information that this regime include, like the chosen licensing commitment, or possible reciprocity requirements (the latter is admittedly less relevant if there is no more than one patent holder for any particular standard). Unfortunately, we were not able to locate Memorandum 8. However, from the information that is provided by CEN/Cenelec, we believe that for both 'old' and 'new' regime statements that (1) statements always relate to specific European Standards (EN), (2) Specific patent disclosures are optional. Furthermore, we will assume all statements to go accompanied with a F/RAND licensing commitment.

The **American National Standards Institute (ANSI)** is best described as an umbrella organization that accredits standards that are developed by representatives of standards developing organizations, government agencies, consumer groups, companies, and others. Its IPR policy is one of the most compact policies around, taking less than one page of paper. It requires organizations that believe to own IPR essential to an American National standards to disclose that information and seeks assurances of royalty free or FRAND commitments (the older ANSI templates also mention non-assertion as a third option). At the same time, ANSI requires that each of its accredited standards developer (ASD) will comply with the normative policies contained in its IPR policy, either by simply copying its policy, or by submitting a written statement that its own policy is in full compliance with ANSI's policy. Note that many declarations done at ANSI can also be found in other SSOs because of its 'umbrella' nature.

The statements submitted directly to ANSI show a wide range of divergence. Some use a (fairly old) harmonized template proposed by ANSI, but many more recent statements are merely free-style letters or email messages (sometimes originally prepared for organizations under the ANSI umbrella). Some organizations added conditions of reciprocity to their commitment, others did not. Some companies do identify specific patents, while others do not and merely mention they believe that they may have essential patents or patent applications for specific standards ('Blanket statements'). There are even blanket statements that do not even reveal for which standard or activity these patent may be essential

The California-based **Broadband Forum** came out of a merger of a number of different telecommunications-orient fora and consortia and standardizes technologies such as DSL, ATM, and future generation IP networks. Its IPR policy is in fact a virtually a literal copy of that of ANSI. The statements and commitments at this body in principle relate to a Broadband Forum 'Report' or

'Working Text', and use a standardized template. In that sense, these are blanket claims. Optionally ('Desired but not required') a declarant may also provide specific patent identities. All together, the IPR statements are fairly similar to those of ISO/IEC/ITU, but a difference is that all commitments are by definition subject to the condition of reciprocity, whereas in the other bodies, this condition was offered as an option.

The **Institute of Electrical and Electronics Engineers (IEEE)** is an engineer's society that publishes a wide range of technical journals. Over time, it has also taken an increasingly important role as a developer of technical standards, of which the Ethernet standard and the IEEE 802.11 wireless standards (better known to the public as 'WiFi'[35]) are among the most successful ones. Concerning IPRs, IEEE has interesting, rather different mechanisms than the SSOs discussed above. This is partly because IEEE has an individual membership and a voting system based on individual votes - although it also the concept of organizational members at a later phase in its existence. We will now describe the IEEE system in short. Firstly, at any meeting of a working group, the chairperson will make a call for any participant (individual or company) to inform him about possible essential patents. Any person is also invited to provide such information at any other time. If the chairperson receives such information, he or she will send a letter to the owner in question, with a request to provide a Letter of Assurance (LoA), using a mandatory template. In this LoA, the assumed owner can indicate whether it believes to own essential patents, or that it is not aware of owning such patents. In the first case, the owner is requested to indicate if it is (1) willing to provide royalty free licenses, (2) willing to provide F/RAND licenses, (3) agreeing not to enforce these patents or (4) unwilling or unable to agree to the above options. Interestingly, the owner may, at its own discretion, include information on the maximal royalty rate it would be charging (i.e. a voluntary ex-ante licensing commitment). Also samples of licensing conditions may be shared. The owner also has to chose between the following two options: (1) to provide specific patent identities, and optionally the essential claims in these patents. In this case, any commitment only concerns the listed patents, or (2) make a 'Blanket Letter of Assurance', where the commitment includes any essential patent the claimant owns now or in the future for the specific standard or the specific project number listed in the LoA. While IEEE publishes an overview of all received Letters of Assurance, this list unfortunately does not reflect all the licensing options discussed above, and also displays a rather wide variety of other licensing conditions and commitments (such as cross-licensing conditions) that were made in times before the current, well-defined template was introduced. While being rather different than the

[35] Technically speaking, 'WiFi' is not the name of the standard but is the commercial name used by the Wi-Fi Alliance for products that sucesfully passed their interoperability certification testing.

IPR policies of other standards bodies, the IEEE confirms that its patent policy is consistent with the ANSI patent policy.[36]

The **Internet Engineering Task Force (IETF)** originally a U.S. government activity, develops and promotes Internet standards, in particular the TCP/IP protocol suit. It was established in 1986. Initially government-funded researchers joined its activities, but in 1991 doors were open to any interested party. The TCP/IP protocol is possibly one of the most used and most successful protocols in the world, and is also the basic building blocks for many other system standards, such as 3GPP. In many respects, IETF is different from other SSO under discussion here. This is most evident from its membership rules (or, better, the lack of it). Involvement and contribution to the IETF processes is on individual basis. There is no such thing as a formal membership or membership environment. People become active in IETF by participating in discussions on mailing lists, contributing drafts on technology, or simply showing up at meetings. As put by some: "Technical competence is the only requirement for contributing; there is no such thing as membership". Also, there is no formal voting mechanism: IETF uses the principle of 'rough consensus'. IETF's current shape and practices are, for a large part, the result of the rather specific culture and attitude of the individuals that were involved in the early development of the internet.

One other area in which IETF is rather different from other standards bodies is that of intellectual property rights. Originally, IETF required members to forego intellectual property protection for a standard altogether. Under pressure from members, this later was changed (Lemley, 2002, p. 92 and p.133). Although the current IETF's policy does know the concept of RAND, its whole policy is rather different from the RAND policy of, say, ETSI. The IETF's IPR policy is discussed in RFC 2026 (BCP 9), originally from 1996. As IPR issues were vigorously discussed in the IETF in the last decade, this document was amended by RFC 3979 (BCP 79) and RFC 4897, which further defines and clarifies the IPR policy. According to the EITF policy[37], its working groups generally prefer unpatented technology, but have the discretion to include technology available under FRAND licensing terms (or even absent such claims!) of they believe this technology to be superior enough to alternatives with fewer patent claims.

The IETF also has special rules dealing with the fact that its participants are individuals, not firms or organizations as such. IETF stipulates that an any individual making a contribution must also notify any IPR he or she reasonably should be aware of, which includes IPR owned by his or her employer

[36] "Instructions for the WG Chair", retrieved on 18 November 2011 from http://ewh.ieee.org/cmte/substations/Published%20Documents/slideset%5B1%5D.pdf

[37] IETF RCF 3979, at Section 8.

or sponsor (if any). IETF allows and actively encourages third-party disclosures; any participant (which is defined in a very broad sense) being aware of any IPR held by any other entity is fostered to disclose that information. If a third party disclosure is made, the IETF Executive Director will contact the assumed patent owner and will ask whether they have any disclosure that needs to be made, per applicable IETF rules.

Patent disclosures must be specific, that is, they must indicate the identity of all IPR believed to be essential. The IPR policy explicitly determines that blanket claims are not allowed – an exception is made for blankets that include a royalty free commitment, though. Disclosures may refer to a specific IETF standards document or contribution (e.g. an RCF), but may also not be related to a specific IETF contribution, but in either case, patent identities need to be provided. Unlike other SSOs, an IPR discloser is requested to withdraw the disclosure if a newer version of the standard no longer requires the patent(s) in question. Also, the IETF Executive Director may request a new disclosure, which must indicate whether a previously unpublished patent was now published, whether a patent application resulted in a patent, and whether the claims of the granted patent still are essential to the standard.

IPR owners are requested to indicate their licensing commitment in the disclosure, which may be RF, FRAND, or non-assertion (i.e. an implementer of the standard is not required to seek a license). Furthermore, the IPR owner is encouraged to include as much licensing information as possible, in order to allow the working group to take informed decisions on inclusion of the technology under consideration.

At the **Open Mobile Alliance (OMA)**, participants are reminded about their duty to disclose any information on essential patents at a variety of events, including any meeting of a Technical Plenary and its groups, and a yearly reminder letter sent out to all its members. The disclosure is done via a standardized template known as the 'IPR Information Statement', and requires the listing if specific IPRs (no explicit allowance of blanket declarations). Upon such a disclosure, the member is asked to submit a second template known as the 'IPR Licensing Declaration', in which it commits itself to reciprocal F/RAND licensing for the patents that were disclosed before. (The commitment that can be made at OMA is defined in its 'application form' (which in fact constitutes a contract) and is, by definition, a reciprocal F/RAND commitment.)

In some sense, the OMA goes a step further than that of the other SSOs discussed here: its policy specifies that members 'will' grand F/RAND licenses for essential patents, and implies that one may refuse to do so only for 'valid' reasons (e.g. the discussed IPR is not essential). This in contrast to all other bodies, where the members (and usually third parties as well) – at least in principle have the

option to inform the SSO that they are not willing to license essential IPR, without requiring a 'valid' reason. While the difference might me theoretical (very few companies refuse to make commitments at any SSO), this feature does distinguish the OMA policy.

The **Alliance For Telecommunications Industry Solutions (ATIS)** also has a policy that is compliant with the one of ANSI, and actually copied the ANSI policy into its own Operating Procedures. It does offer a template that is quite similar to the one at IEEE, offering quite a few licensing options, including the choice of whether the licensing commitment relates to all the work on a given standard, or is restricted to the patents that are identified by the declarant. The use of this harmonized for is optional, though.

The **Telecommunications Industry Association (TIA)** also follows the ANSI policy. A remarkable aspect, however, is that TIA 'encourages, but does not require' the disclosure of essential patents.[38] Also, "*Standards are proposed or adopted by the TIA without regard to whether their proposal or adoption may in any way involve patents or intellectual property on articles, materials, or processes.*".[39] In this sense, TIA differs substantially from other SSOs, where disclosure (though not commitments) are mandatory and the principle is that standards are not approved unless all known essential patent holders have committed themselves to at least F/RAND licensing. This seems somewhat contradictory to ANSI's policy. Assumingly, TIA standards that are proposed for American National Standards via ANSI must meet stricter requirements.

Confusingly, the General Patent Holder Statement and the Specific Patent Holder Statement in TIA's most recent Engineering Manual (TIA's most important ruling), differ in several respects from the current templates as available from the TIA website (and which seem to go into the current database). TIA offers two on-line IPR databases, one of which is a 'List prior to 2001', and a database containing more recent statements. We collected the data from both.

Table B-1: Overview of locations of the IPR policies and related documentation.

ANSI	Policy: http://publicaa.ansi.org/sites/apdl/Reference%20Documents%20Regarding%20ANSI%20Patent%20Policy/ANSI%20Patent%20Policy%20-%20Revised%202008.pdf Guidelines: http://publicaa.ansi.org/sites/apdl/Documents/Standards%20Activities/American%20National%20Standards/Procedures,%20Guides,%20and%20Forms/Guidelines%20for%20Implementatio

[38] TIA Engineering Manual, October 2009 (5th Edition), at page 66. Retrieved on 18 November from http://www.tiaonline.org/standards/procedures/manuals/documents/tia_eng_manual-5th_edition_102009_final.pdf.
[39] Ibid, page 68.

	n%20of%20ANSI%20Patent%20Policy%202011.pdf Reference documents: http://publicaa.ansi.org/sites/apdl/Reference%20Documents%20Regarding%20ANSI%20Patent%20Policy/Forms/AllItems.aspx Statements: http://publicaa.ansi.org/sites/apdl/Patent%20Letters/Forms/AllItems.aspx
ATIS	Web: http://www.atis.org/legal/patpolicy.asp Policy: http://www.atis.org/atisop.pdf (at Section 10) Statements: http://www.atis.org/legal/patentinfo.asp
Broadband Forum	Policy: http://www.broadband-forum.org/about/download/IP_Policy.pdf Statements: http://www.broadband-forum.org/technical/ipdeclarations.php
CEN, CENELEC	Statements: ftp://ftp.cenorm.be/CEN/WorkArea/IPR/Patents.pdf Policy: ftp://ftp.cenorm.be/BOSS/Reference_Documents/Guides/CEN_CLC/CEN_CLC_8.pdf
ETSI	Web: http://www.etsi.org/WebSite/AboutETSI/IPRsInETSI/IPRsinETSI.aspx Policy: http://www.etsi.org/WebSite/document/Legal/ETSI_IPR-Policy.pdf Guide: http://www.etsi.org/WebSite/document/Legal/ETSI_Guide_on_IPRs.pdf Statements (on-line): http://ipr.etsi.org/ Statements (SR 000 314 report): http://webapp.etsi.org/workprogram/Frame_WorkItemList.asp?SearchPage=TRUE&qSORT=HIGHVERSION&qINCLUDE_SUB_TB=True&butSimple=++Search++&qETSI_STANDARD_TYPE=&qETSI_NUMBER=000+314&qETSI_ALL=TRUE&qMILESTONE=&qACHIEVED_DAY=&qACHIEVED_MONTH=&qACHIEVED_YEAR=&qREPO
IEC and IEC/JTC1	Policy: http://www.iec.ch/members_experts/tools/patents/form_guidelines.htm Template: http://www.iec.ch/members_experts/tools/patents/documents/patent-form.doc Statements: http://patents.iec.ch/
IEEE	Policy: http://standards.ieee.org/develop/policies/bylaws/sect6-7.html Template: https://development.standards.ieee.org/myproject/Public//mytools/mob/loa.pdf Chart of patent procedure: https://development.standards.ieee.org/myproject/Public/mytools/mob/flowchart.pdf Statements: http://standards.ieee.org/about/sasb/patcom/patents.html
IETF	Policy: http://www.ietf.org/rfc/rfc3979.txt, with some clarifications provided in http://www.ietf.org/rfc/rfc4879.txt Web: https://datatracker.ietf.org/ipr/about/ Form for specific declarations: https://datatracker.ietf.org/ipr/new-specific/ Form for general declarations: https://datatracker.ietf.org/ipr/new-generic/ Form for third-party declarations: https://datatracker.ietf.org/ipr/new-third-party/ Statements: https://datatracker.ietf.org/ipr/
ISO and ISO/JTC1	Web: www.iso.org/patents Policy: http://isotc.iso.org/livelink/livelink/fetch/2000/2122/3770791/Common_Policy.htm Declaration Template: http://isotc.iso.org/livelink/livelink/fetch/2000/2122/3770791/ITU_ISO_IEC_Patent_Statement_and_Licensing_Declaration_Form.pdf?nodeid=6297442&vernum=-2 Statements (excluding JTC-1): http://isotc.iso.org/livelink/livelink/fetch/2000/2122/3770791/ISO_Patents_database_%28without_JTC1_Standards%29.html?nodeid=4630277&vernum=-2 Statements (only JTC-1): http://isotc.iso.org/livelink/livelink/fetch/2000/2122/3770791/JTC1_Patents_database.html?nodeid=3777806&vernum=-2
ITU	Web for ITU-T: http://www.itu.int/en/ITU-T/ipr/Pages/default.aspx Web for ITU-R: http://www.itu.int/ITU-R/index.asp?redirect=true&category=study-groups&rlink=patents&lang=en&company=&recommendation=&patent=&country=&receiveddate_type=&receiveddate_dd=&receiveddate_mm=&receiveddate_yyyy=&SearchText= Policy: http://www.itu.int/en/ITU-T/ipr/Pages/policy.aspx Guidelines: http://www.itu.int/dms_pub/itu-t/oth/04/04/T04040000010002PDFE.pdf Forms: http://www.itu.int/dms_pub/itu-t/oth/04/04/T04040000020002PDFE.pdf

	Statements for ITU-T : www.**itu**.int/ipr/ Statements for ITU-R: http://www.itu.int/ITU-R/index.asp?redirect=true&category=study-groups&rlink=patents&lang=en&company=&recommendation=1387&patent=&country=&receiveddate_type=after&receiveddate_dd=DD&receiveddate_mm=MM&receiveddate_yyyy=YYYY&SearchText
OMA	Web: http://www.openmobilealliance.org/AboutOMA/IPR.aspx Policy http://www.openmobilealliance.org/document/OMA-Reference-2007-0002R01.pdf (in Section 5) Guidelines: http://www.openmobilealliance.org/document/Member_IPRGuidelines_v53006.pdf Statements: http://www.openmobilealliance.org/AboutOMA/IPR.aspx
TIA	Web: http://www.tiaonline.org/standards/procedures/ipr/index.cfm Policy: http://www.tiaonline.org/standards/procedures/manuals/documents/tia_eng_manual-5th_edition_102009_final.pdf Guidelines: http://www.tiaonline.org/standards/procedures/manuals/documents/IPRGuidelines_edition1_companion_to_4th_ed_engmanual.pdf General Statement Template: http://www.tiaonline.org/standards/procedures/ipr/ipr_statement.cfm?form_type=general Specific Statement Template: http://www.tiaonline.org/standards/procedures/ipr/ipr_statement.cfm Statements: http://www.tiaonline.org/standards/procedures/ipr/ipr_list.cfm