Chapter 8
Open Standards and Intellectual Property Rights[*]

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1. Introduction

Compatibility standards are used to govern the interaction of products and components in a technological system. In other words, they are the shared language that technologies use to communicate with one another. Standards are particularly important in the information and communications technology industries, where there are large numbers of inter-dependent suppliers and a very rapid pace of technological change. This chapter explores the inherent tension between cooperation and competition in the standards creation process, with a special emphasis on the role of intellectual property rights. These issues are closely linked to several key themes of Open Innovation, including the growing significance of IP-based business models, and the trend towards vertical dis-integration between technology development and commercialization.

While new standards can emerge from a market-based technology adoption process, this chapter focuses on the role of voluntary Standard Setting Organizations (SSOs). These organizations provide a forum where firms can collaborate in the design and promotion of new compatibility standards. Most SSOs promote the adoption of open standards—where the term "open" implies that technical specifications are widely, perhaps even freely, available to potential implementers.[i] However, open-ness can pose a dilemma for individual firms hoping to benefit from SSO participation. While open-ness increases the probability of coordination on a particular standard (and hence its total expected value), it can also increase the intensity of competition, making it harder to capture that value once the new specification new standard is introduced. As a result, SSO participants are often tempted to take actions that "close off" a standard when those actions also give them a competitive edge in the standards-based product market. To put it crudely, SSO participants usually want all of the technology needed to implement a standard to be open—except for their own.

This tension between value creation and value capture — a key concern of open innovation — is also an inherent feature of standards creation, and is particularly evident in the ongoing debate over intellectual property rights (IPR) in the standard setting process. On one side, proponents of the open source model are working to create a set of legal institutions that make it impossible for firms to capture value through IP licensing. On the other side, some firms are actively "gaming" SSOs in an effort to ensure that industry standards will eventually infringe on their own patents. Meanwhile, SSOs and policy makers are stuck in the middle trying to devise a framework that balances the legitimate interests of the various interested parties.

This chapter's central argument is that changes in the nature of the innovation process—particularly an increase in the number of specialized technology developers whose business models rely heavily on IP—have led to an increasingly contentious standard setting process. While there is nothing inherently harmful about the fact that the trade-off between value creation and value capture has become more severe, SSOs and policy makers need to be aware of this change in the economic and technological landscape when formulating IP policies and enforcing regulations.

The chapter begins by reviewing the literature on non-market standard setting and developing a framework for thinking about the relationship between standards, technologies, and implementations (i.e. products). It goes on to consider a number of strategies that technology developers may use to capture the value created by new compatibility standards. Firms that do not rely heavily on intellectual property rights to capture value are often praised by standards practitioners for "cooperating on standards and competing on implementation."[ii] However, the chapter uses a number of examples to illustrate how many firms appear to be moving away from cooperation on standards and towards business models that emphasize IP ownership as a primary source of revenues. The leading example of this phenomenon is the well-known Rambus case, where a new entrant successfully manipulated the standard setting process by exploiting loopholes in the patent system (Graham and Mowery 2004; Tansey et al 2005).

The evidence of increasing conflict over IPR in the standard setting process raises the question, What has changed to make "cooperating on standards and competing on implementation" less effective? The emergence of an innovation system characterized by Open Innovation provides a potential answer. In particular, the broad trend towards increased specialization in technology development and commercialization has created a more active technology input market, which many firms now rely on to procure standards-based inputs and/or monetize their inventions. However, many of the entrepreneurial but undiversified firms that supply the technology input market do not "compete on implementation" (because they specialize at supplying technology) and therefore have few incentives to "cooperate on standards."

How should SSOs respond to a less cooperative standards creation environment? In the past, most SSOs stayed away from questions related to the licensing of IPR, for fear of alienating members or coming under the scrutiny of antitrust authorities.[iii] However, over the last few years, a number of SSOs have experimented with changes to their IPR policies in an attempt to maintain a balance between encouraging cooperation and ensuring participation. The creation of an explicit antitrust "safe harbor" for *ex ante* (i.e. pre-standards) licensing negotiations should also be considered as a way of encouraging SSOs to govern the tradeoff between the collective benefits of high-quality standards against the legitimate interests of IPR holders more effectively.

2. An Overview of Standards Creation

Compatibility standards are a set of rules for the design of new products. These rules facilitate coordination between independently designed products or components by establishing a common interface to govern their interactions. Much of the existing literature on compatibility standards has focused on network effects, and their ability to create positive feedback in the technology adoption process. This often leads to intense competition between technologies and the emergence of a single dominant technology or design as the industry standard. This process is often referred as a "standards war," and the list of well-known examples includes VHS versus Betamax in video recording, Apple versus Windows in operating systems, and Explorer versus Netscape in Internet browsers. The competitive dynamics of standards wars have been studied extensively, and the interested reader should see Varian and Shapiro (1999) for a thorough and easily accessible survey of this literature.

This chapter emphasizes the role of voluntary non-market Standard Setting Organizations as an alternative to standards wars. In their survey of the economic literature on standardization, David and Greenstein (1990) used the term *de jure* standard setting to describe the work of SSOs. Although this term suggests that SSOs have legal authority, in reality this is rarely the case. Most SSOs are voluntary associations with little or no power to enforce the technical rules they produce. However, because these groups operate in industries where the demand for coordination is large, SSOs can have a considerable impact on the rate and direction of technological change—primarily through their influence on the bandwagon process that leads to the adoption of a particular technology as the industry standard.

The term SSO can be applied to a broad range of institutions. At one end of this spectrum, there are a number of large well-established Standards Developing Organizations (SDOs) like the International Telecommunications Union (ITU) or the Institute for Electrical and Electronic Engineering (IEEE). Many of these groups have been practicing collaborative innovation (i.e. technology sharing) for hundreds of years. In the middle, there are a number of smaller industry- or technology-specific groups—often labeled consortia. At the other end of the spectrum are the relatively informal standards developing communities that comprise the open-source software movement.[iv] While these groups approach the problem of standardization in very different ways, their common goal is to create new technologies that will be widely implemented and adopted.

There is a relatively small body of formal theory related to non-market standard setting in SSOs. Much of this work is focused on issues of bargaining and delay, and emphasizes the fact that removing the standard setting process from the marketplace does not eliminate self-interested or strategic behavior by the sponsors of competing technologies. Farrell and Saloner (1988) use a simple model of standard setting based on the war of attrition to compare standard setting in markets and committees. They conclude that while markets are faster, committees are more likely to produce coordination on a single compatibility standard. Farrell (1996) and Bulow and Klemperer (1999) generalize and extend this model. Simcoe (2005) develops a slightly different model that emphasizes the role of collaborative design as well as competition in the committee standard-setting process. His basic conclusion is that the process of design-by-committee will produce long delays and "over design" when there are significant distributional conflicts over competing proposals. There are also a number of papers that theorize about other aspects of SSOs. For example, Lerner and Tirole (2004a) study the process of "forum shopping" in which firms seek an SSO that will endorse their own technology; Foray (1994) considers the importance of free-rider problems in collaborative design; and Axelrod et al. (1995) examine alliance formation among the sponsors of competing technologies in a hybrid (market and committee) setting.

Most of the empirical evidence on the committee standard setting process is based on case studies. Examples include Weiss and Sirbu (1990), Farrell and Shapiro (1992), and Bekkers et al (2002). There is also a large literature outside of strategy and economics—primarily written by standards practitioners—which sheds some light on committee standard setting. The leading authors in this literature include Cargill (1989; 1997), Krechmer (2005), and Updegrove (www.consortiuminfo.org). Recently, however, a number of large-sample of empirical studies of SSOs have started to appear. These include papers by Simcoe (2005) on the distributional conflicts and delay; Rysman and Simcoe (2005) on the economic and technological impact of SSOs; Toivanen (2004) on committee choices in cellular standardization; and Dokko and Rosenkopf (2003) as well as Fleming and Waguespack (2005) on technological communities and standards committee participation. The empirical work most closely related to this chapter are the empirical case studies by Bekkers et al (2002) and West (2003), that examine the intellectual property strategies of SSO participants, and the question of how "open" to make a standards-based product.

This chapter focuses on the trade-off between open-ness and control in standards creation. While this is a central theme in the literature on standards, it has not received a great deal of attention from empirical researchers.[v] This partly reflects the fact that open-ness is hard to define (e.g. West, 2006). For some, open-ness means that anyone has a right to participate in the standards developing process. This "open process" view is particularly common among large and well established Standards Developing Organizations. For others, open-ness means that anyone who wants to implement a standard can do so on reasonably equal terms. This is the pragmatic "open outcomes" view taken by many consortia, and some larger SSOs (such as the IETF). Finally, there are those who believe that a standard is not truly open unless it can be *freely* adopted, implemented, and extended by anyone who wishes to do so. The strongest advocates for this viewpoint are found within the open-source software community, which has developed a number of innovative legal institutions to safeguard the widespread availability of its work (Lerner and Tirole, 2005).

For this chapter, it is important to note the somewhat subtle distinction between SSOs' use of the term "open" and that of Open Innovation. In particular, Chesbrough (2003, pp. xxiv) describes open innovation as, "a paradigm that assumes firms can and should use external ideas… and external paths to market." Open standards and open innovation both refer to a process that involves sharing or exchanging technology across firm boundaries. The difference is that the objective of open standard setting is to promote the adoption of a common standard, while the objective of open innovation is to profit from the commercialization of a new technology. In other words, open innovation might take place in a regime of either open or closed standards.

Why, then, do firms participate in "open" standards development? The short answer is that open standards usually produce more value than closed standards. For consumers, open standards create value by promoting competition between implementations. This leads to a combination of lower prices and improved product quality. For the firms selling products that implement a standard, open-ness increase demand by resolving the uncertainties associated with potential coordination failures. Open-ness can also reduce implementers' costs through explicit restrictions on the "tax" that can be imposed by technology licensors or through *ex ante* (i.e. pre-standardization) competition between the sponsors of rival technologies.

The situation is somewhat more complicated for firms that produce the technologies used to implement a standard. It is reasonable to assume that these firms also participate in SSOs because they hope to capture some of the value associated with the creation of a new compatibility standard. Moreover, these companies will benefit from the additional value created by adopting an open specification. However, these firms might be willing to adopt a closed specification that produces less total value when it allows them to capture a larger share of the pie. In other words, they might settle for being the "tax collector" in a world of closed standards—particularly when the alternative looks something like perfect competition.

Firms that develop standardized technologies must confront the trade-off between open-ness and control in developing a business model for commercializing their innovations (Chesbrough 2003, pp. 64). In particular, firms that choose to specialize in developing input technologies and licensing them to implementers will bear the costs associated with a closed standard—including the possibility that firms will search for open substitutes to their proprietary technology. However, these costs may be tolerable for some firms, particularly small companies that cannot easily access the complementary assets needed to "compete on implementation" (Teece, 1986; Gans and Stern, 2003)

To clarify this idea, Figure 8.1depicts a world in which there is a continuous trade-off between open-ness and control. This tradeoff is represented by a curve that indicates the share of value that a firm sponsoring a particular standard could capture as a function of the total value produced by that standard. In the limiting case of a completely open standard, there is a great deal of value created but the firm does not capture any. Conversely, when a standard is completely closed, it produces little or no value but the firm captures all of it.

[INSERT FIGURE 8.1 ABOUT HERE]

The objective of a profit-maximizing firm is to choose a spot on this curve that maximizes the total amount of value it captures (i.e. the rectangle underneath any spot on this curve). The objective of an open SSO is to maximize the total value produced by the standard.[vi] However, while an SSO sets the rules under which a standard is chosen, it cannot simply mandate the socially-optimal choice. The SSO is constrained by the need to ensure that firms participate in the decision-making process—and competition between SSOs may tighten this constraint. The next section of this chapter develops a simple framework for thinking about various factors that will influence the severity of the tradeoff between open-ness and control faced by SSO participants, which is captured by the shape of the curve in Figure 8.1.

3. Standards, Technology, and Implementation

What is the value of a standard? The answer, of course, is that it depends on whether the standard produces the coordination intended by its designers. For example, the technical standards used to run the Internet are extremely valuable. But without them, we would probably have a fully functional "Internet" running on a completely different set of protocols. In other words, standards have relatively little value as technological artifacts. It is only through implementation—and ultimately through coordination and inter-operability—that compatibility standards produce any value for society.[vii]

Nevertheless, even before implementation, not all compatibility standards are created equal. There may be significant differences in technological quality (e.g. analog versus digital standards for audio transmissions). There is also variation in the extent to which the value of a product is tightly linked to a particular standard. For example, the value of software running on Microsoft Windows is linked quite tightly to the underlying operating system standard. In other cases, even though a standard is critical to the functionality of a product, that product's value is largely based on other features (e.g. MP3 players like Apple's iPod, or fashionable cellular handsets).

In general, the link between compatibility standards, input technologies, and the value of a product or implementation can be quite complex. Figure 8.2 presents a simple framework for thinking about the how standards, products or implementations, and technologies interact with one another to create value.

[INSERT FIGURE 8.2 ABOUT HERE]

The right leg of this triangle—the direct link from standards to the value of a product—is the focus of the literature on "network effects" described above. The central insight of this literature is that the demand for coordination produces positive feedback which causes markets to gravitate towards one standard or another, even when there are many to choose from. The fact that this arrow runs from standards to implementation is meant to reflect the fact that coordination creates value for compatible implementations.

However, some standards will be less costly to implement than others, or have better performance characteristics, or prove more flexible. So, even if all standards are more or less equal when it comes to the value of coordination, a standard can still influence the value of a product through its impact on engineering and design. This effect is captured in Figure 8.2 by the arrows from standards to technology, and from technology to implementation.

The arrow running from standards to technology represents the impact that a standard may have on the relative value of substitute input technologies. When a particular technology is essential to implement an industry standard, or leads to sizable advantages in cost or performance, the standards creation process will influence the value of that technology. Timing is a critical part of this story. Technologies that implementers may see as close substitutes *ex ante*, may not be comparable in the wake of the standard setting process.

The impact of standards choice on the value of input technologies (i.e. the magnitude of the arrow from standards to technology) depends on whether implementation requires firms to make substantial technology-specific investments. When firms make large specific investments as part of the implementation process, the choice of a standard leads to large switching costs and creating opportunities for a technology owner to "hold up" potential implementers (see the discussion of Rambus below). In principle, if there are no technology-specific investments, implementers could simply agree to coordinate on an alternative technology. In practice, there are often substantial costs associated with the coordination process so that specific investments only add to the *ex post* technology-differentiation induced by the standards creation process.

The arrow in Figure 8.2 running from technology to standards represents the role of technical merit in the SSO decision-making process. As rules, compatibility standards place constraints on the use of various technologies in the design of new products. Some rules are clearly better than others. All else equal, everyone involved in the standard setting process would like to adopt specifications that create value by ensuring that coordination takes place without raising costs or constraining performance. Unfortunately, all else is rarely equal. Conflicting interests created by the arrow from standards to technology may interfere with the smooth functioning of the arrow running from technology to standards—resulting in inferior specifications or a relatively inefficient standardization process.[viii] This is just another way of describing the tension between open-ness and control described in the previous section.

Finally, the left leg of the triangle in Figure 8.2 captures the relationship between the quality of input technologies and their value as a product or implementation. (It can be thought of as a tremendous oversimplification of a large literature in strategy and economics on the commercialization of technological innovations.) One of the key themes in Open Innovation (Chesbrough 2003, pp. xxii) is that this arrow—the left leg of the triangle—has increasingly shifted from a closed process that takes place inside the boundaries of the firm to an process that takes place within the technology input market.

Economists going back to Schumpeter (1942), Nelson (1959), and Arrow (1962) have recognized that technology input-markets are often characterized by market failures that can be traced to the nature of innovative activity—which has high fixed costs of invention, large uncertainties, low marginal costs of reproduction, and significant externalities. The strategic management literature has considered how firms try to appropriate the value created by technological innovations given these problems with the market. This literature begins with Levin et al (1988) and Teece (1986), and extends through Cohen, Nelson, and Walsh (2000), and Anton & Yao (2004). Its main insight is that firms have a variety of "appropriability mechanisms" at their disposal, including patents, secrecy, lead-time, and complementary assets such as manufacturing or sales and service capabilities (i.e. vertical integration). Moreover, the effectiveness of these appropriability mechanisms depends on features of the technology, such as the need of buyers or suppliers to make large design-specific investments, as well as the competitive environment.

When firms have access to a wide range of appropriability mechanisms, they can make the trade-off between open-ness and control less severe by "cooperating on standards and competing on implementation." Competing on implementation is a catch phrase for using time-to-market advantages, secrecy, superior design and marketing, or production cost advantages to extract value from standardized products. The key point is that "control" of a standard is simply *one way* for a firm to solve the problem of generating profits to cover the fixed costs of innovation and/or standards creation. When firms focus on competing along these other dimensions , the tradeoff between open-ness and control in the standards creation process becomes less severe. However, when firms are unable to compete in these other dimensions (e.g. because consumers are highly price sensitive and do not respond to branding efforts), the standard setting process becomes a game of "picking winners" where political competition is likely to be fierce.

Figure 8.3 illustrates this idea. The lines in this figure represent the same tradeoff between open-ness and control depicted in Figure 8.1. Now, however, there are several lines which represent the extent to which competition takes place on implementation rather than standards. In this picture, when firms compete on implementation instead of standards, it is possible for them to create more overall value for a given level of open-ness.[ix] Since the marginal cost of open-ness (in terms of value captured) has declined, we can see that "cooperating on standards" is a natural complement to "competing on implementation." Moreover, the SSO is a major beneficiary of this shift, since it can push standards further to the right while continuing to satisfy constraints imposed by firm-profitability and/or competition to attract participants between SSOs.

[INSERT FIGURE 8.3 ABOUT HERE]

SSOs' ability to loosen the constraint imposed by the tradeoff between open-ness and control depends on participating firms' ability to "compete on implementation" using the various appropriability mechanisms discussed above. However, the broad shift towards an "Open Innovation" model of technology commercialization may be making it harder for SSO participants to do this. As Chesbrough documents, the "closed" process of R&D and commercialization within a single firm was part of an industrial age business model that grew out of concerns with the problems of appropriating any rents created by new technologies. Today we are observing a broad shift away from this business model towards a new set business models characterized by a variety of different strategies and institutional arrangements such as venture capital, start-ups, spin-outs, and proactive IPR licensing. This broad trend towards vertical dis-integration between technology development and commercialization has probably increased the efficiency of the innovation process and led to improvements in the allocation of risk. At the same time, it appears to have made it harder for SSO participants to stay on the outermost line in Figure 8.3. This shift towards "competing on standards" is evident in the changing role of IPRs in the open standard setting process, which is taken up in the next section.

4. Intellectual Property Strategies in Standards Creation

While the term "intellectual property" encompasses patent, trademark, and copyright protection, this section will focus on patents, which are the vast majority of standards-related IPR. Patents give an inventor the right to exclude others from using their invention for a specified period of time (Graham and Mowery, Chapter 9). From a policy perspective, the role of a patent system is to create incentives for innovation by providing a legal solution to inventors' appropriability problems. This incentive will clearly be especially important for firms that cannot easily access or acquire the complementary assets required to profitably commercialize their inventions. As a result, patents play an important role in promoting vertical specialization in research and development by limiting the hazards faced by specialized technology developers with business models that call for selling inputs rather than implementations.

On the other hand, any administrative process granting potentially valuable property rights will almost certainly create some rent-seeking behavior. Over the last two decades, there has been a notable increase in the number of U.S. patent applications. The majority of these applications have been granted, which has led to an increase in the scope of patentable subject matter and arguably a decline in average patent quality. A number of authors have considered various explanations for this surge in patenting and explored a number of its effects (e.g. Jaffe and Lerner 2004, and works cited therein).

Standards developers face a fundamental challenge with respect to IPRs. While patent proliferation means that more parties now have the right to impose a "tax" on implementation, the shift towards open innovation has created an environment where "taxation" appears to be a more attractive strategy. Increasingly, SSOs and their participants are facing difficult questions about how and when to reveal information about patents; the rights and obligations associated with SSO participation; the precise meaning of SSO policies; and whether the government will play an active role in enforcing them. It is not clear whether the existing framework of self-governance will be adequate to handle these changes.

Between 1995 and 2005, there were a number of legal disputes over the appropriate use of IPRs in the standard setting process. The two most significant examples, *Dell* and *Rambus*, both involved allegations that a firm failed to disclose essential IPRs—in violation of SSO policy—and then sought to license the undisclosed technology to potential implementers.[x] Both led to actions by the FTC.[xi] These cases and several others have led to a growing interest among legal scholars in the antitrust and intellectual property issues associated with standards creation. These issues are covered by the antitrust and standard setting bibliography prepared by the American Bar Association (ABA 2003

), and the online transcripts from a series of hearings held in February 2002 (FTC 2002).

While a number of economists and strategic management scholars have also taken an interest in standard setting and IPRs, this literature remains small and somewhat fragmented.[xii] For example, while Bekkers et al (2002) and Rysman and Simcoe (2005) present some evidence of increasing intellectual property disclosures at specific SSOs, no one has collected the data to illustrate any systematic increase in the number of standard-related patents or IPR disputes. Table 8.1 offers a brief overview of several IPR strategies that seem to be emerging at various SSOs, or have been discussed in the legal, practitioner, economics, or strategic management literatures.

[INSERT TABLE 8.1 ABOUT HERE]

The strategies listed in Table 8.1 can be separated along two dimensions. The first dimension corresponds to whether the strategy's objective should be characterized as open or closed. Open strategies, such as IPR contributions, anticipatory standard setting, and defensive patent pools encourage value creation by enhancing the availability of the underlying technology. Closed strategies, such as licensing or hold-up, use IPRs as a mechanism to capture a share of the value created by a standard. The second dimension corresponds to the *transparency* of the strategy (i.e. whether other SSO participants are meant to know what the firm is doing). While all of the open strategies are transparent, this is not true for closed strategies. Some closed strategies—such as disclosure and licensing, or the formation of a royalty-generating patent pool—are consistent with a reasonably transparent standard setting process. Other closed strategies—such as secretly amending patents to cover a standard contemplated by an SSO, or conducting after-the-fact patent searches focused on exploiting industry standards—rely on secrecy and the informational advantages associated with holding a patent or pending application.

The simplest example of an open IPR strategy is the decision to disclose, but not assert, essential patents. For all of the attention paid to more aggressive IPR tactics, there are still a large number of firms who disclose the existence of their IPR to SSOs in a timely manner and make it available for free.[xiii] The decision to give away IPRs is usually based on an explicit recognition that doing so will improve the odds of a standard's success in either a committee or the marketplace. For example, the original sponsors of the Ethernet protocol (Digital, Intel and Xerox, sometimes called the DIX alliance) made a conscious decision not to pursue patent royalties before submitting the technology for standardization through the IEEE (von Burg, 2001). Each of the companies in the DIX alliance was clearly in a position to benefit from the rapid dissemination of a free networking standard, given their large stake in complementary lines of business like computers and printers. Moreover, each of these firms had reason to fear the emergence of a proprietary protocol as the *de facto* local area networking standard.

One of the weaknesses of the traditional "disclose but don't assert" strategy in a world of rapidly proliferating IPRs is that it requires a great deal of coordination. This is because patents apply to technologies rather than standards (see Figure 8.2). When a number of different technologies are needed to implement a single standard, it only takes a single firm asserting their IPR to create considerable uncertainty about potential costs. Royalty free patent pools are an open strategy that attempts to address this coordination problem by aggregating the IPRs needed to implement a standard. For example, the Cable Labs consortium maintains a royalty-free patent pool containing a number of patents needed to implement standard cable modem protocols (Lo 2002). In addition to ensuring access, these pools can lower potential implementers' IPR search and transactions costs.

SSOs with a royalty-free IPR policy, such as the World Wide Web Consortium, can be thought of as a *de facto* patent pool. There are even reports that IBM has contemplated the creation of a "public patent pool" in order to provide a formal mechanism for placing IPR in the public domain (Lohr 2005). The open-source licensing model (West and Gallagher, Chapter 5) is a logical extension of royalty free patent pooling. The innovative feature contained in most open-source licenses is a "grant-forward" provision which tries to make open-ness a self-sustaining feature of the technology by limiting implementers' ability to develop proprietary extensions.

While open-source licensing and variations on the royalty-free patent pool are innovative open strategies, it remains to be seen whether any of these approaches will actually solve the problem of a lone patent-holder's ability to hold a standard hostage. Some practitioners advocate "anticipatory" standard setting (i.e. developing standards well ahead of the market) as a simpler approach to this problem (Baskin et al, 1998).[xiv] The advantages of anticipatory standards are twofold. First, they help to establish a body of prior art that can prevent companies from pursuing opportunistic patents designed to cover standards-related technology. In this sense, the anticipatory strategy closely resembles the practice of pre-emptive patenting or publication. Second, the anticipatory standard setting process may actually run smoother because it is further from the pressures created by imminent commercialization. The weakness of anticipatory standard setting is that it requires a great deal of foresight (and probably some good luck). Ongoing changes to the patent system, the process of university technology transfer, and the pace of commercialization also threaten to limit the scope of this strategy.

The most straightforward “closed” IPR strategy is to license one or more patents for an essential technology to standards implementers. However, it is important to draw a distinction between firms who disclose their patents during the standards creation process, and those who wait until the process is over. One of the best known examples of the disclosure and licensing strategy comes from public key cryptography. In the late 1970s, a firm called RSA obtained a number of extremely strong patents covering the basic methods of public key cryptography. RSA regularly disclosed these patents—which were fairly well known in any case—to SSOs working on computer security or cryptography standards. Even though most SSOs have a preference for standards that do not require the use of IP unencumbered technology, the significance of RSA’s invention and the scope of its patents led to the adoption of a number of specifications that required implementers to seek a license from RSA.[xv]

While RSA’s patent licensing strategy was carried out within the open standard setting process, some firms do not disclose their IPRs prior to the adoption or implementation of a standard. By waiting for a standard to be implemented and perhaps widely adopted before demanding royalties, these firms can take advantage of switching costs that naturally arise in many settings. These costs include product designs, specialized investments in manufacturing or distribution, and the accumulated experience with a particular technology. Section 2 described how these endogenous switching costs can *change* the value of an essential technology. This is an example of the “hold up” problem, which has a long history in economics (e.g. Farrell et al, 2004).

Table 8.1 distinguishes between two slightly different variations on the “hold-up” strategy. The first of these strategies, labeled “active hold-up” is exemplified by Rambus’ actions in an SSO that developed standards for computer memory. Rambus participated in the SSO but failed to disclose that it had a number of pending patent applications related to technology under consideration.[xvi] The firm then demanded that implementers license the patents after the standard was established and its pending applications were granted. The Rambus case generated a great deal of controversy—much of it centering on the company’s efforts to subvert the transparency of the standards creation process.

There is another variation on the hold-up strategy that is labeled “ex-post licensing” in Table 8.1. In this strategy, firms that do not necessarily participate in an SSO use the creation of new standards as an opportunity to extract rents from their existing patent portfolio. For example, in 1999 a small firm called Eolas sued Microsoft for including so-called “applet” and “plug-in” technologies in its Internet Explorer web-browser, and was initially awarded over $500 million. In response, the W3C appealed for a USPTO review of the patent in question, suggesting that, “the impact will be felt… by all whose web pages and applications rely on the stable, standards-based operation of browsers threatened by this patent.” Another example of this rent-seeking strategy was British Telecom’s attempt to assert a patent on the method of hyper-linking that is the basic method of creating links between pages on the World Wide Web. Recently, firms that specialize in acquiring patents purely for litigation—often derided as “patent trolls” by the targets of their lawsuits—have emerged as significant players in some technology markets.

The apparent increase in ex-post IPR licensing strategies may also be related to the re-emergence of patent pools. In 1995, the DOJ issued guidelines relaxing its prior restrictions on the formation of patent pools. This ruling appears to have opened the door for patent pools to serve as a coordinating mechanism for firms who see standards as a tool for boosting licensing revenues from an existing patent portfolio. This takes place through firms like Via Licensing, which has issued a "call for patents" to solicit potential licensors of technology related to a variety of established standards, such as the IEEE's 802.11b standard for wireless networking. In some cases, the goal of creating a royalty-generating patent pool is an explicit part of the initial standards creation effort. This practice is common for media-format standards, such as MPEG, CD, and DVD.

It is often difficult to evaluate the competitive implications of patent pools or cross-licensing agreements. These arrangements can encourage competition—particularly when they solve the "patent thicket" problem by reducing the transaction costs associated with repeated bilateral licensing for complementary technologies (Lerner and Tirole, 2004b) On the other hand, it seems clear that they can also be used by incumbent firms to create entry barriers or raise rivals costs. These issues are addressed by a number of authors who have written about the widespread use of cross-licensing agreements in high-technology industries (Grindley and Teece, 1997; Hall and Ziedonis, 2001). However, Bekker's study of GSM alliance formation is one of the only papers to explore how these arrangements both influence and respond to the creation of new compatibility standards.

The final category of Table 8.1, "disclosure strategies" describes a variety of tactics that firms may use in the standards creation process. This chapter briefly discussed the distinction between transparent IPR strategies and "active hold-up." However, it is clear that there are a number of more subtle approaches to IPR disclosure. For example, some practitioners claim that Cisco used IPR disclosures at the IETF to discourage the adoption of a new routing protocol that might emerge as a competitor to its preferred technology (Brim 2004). The issue of disclosure strategy raises a host of questions related to the costs and benefits of delay, forum shopping, and competition between standards. Many of these issues call for additional research.

In describing a number of different standards-related IPR strategies, this section has suggested several possible reasons for the apparent proliferation of IPR issues at many SSOs. This chapter has focused primarily on a single explanation—the trend towards an innovation system of open innovation that involves a greater reliance on IPR-based business models. However, there have also been changes in the quantity and average quality of issued patents as well as the increase in standards-related patent pools. Moreover, the success of a few firms like Qualcomm and IBM at licensing their standards-related IPR may have raised firms' awareness of the strategic possibilities in this area.

It seems likely that each of these explanations for the increasing awareness of the strategic possibilities of IPR in compatibility standards is at least partly correct, and they may be working to reinforce one another. The actual size of the increase in IPR controversy and precisely how much can be attributed to each of these explanations is a subject for future research. What is clear is that the increasing controversy surrounding IPR strategies in standard setting presents a clear challenge for SSOs. The next section examines how these organizations are responding.

5. Intellectual Property Rules at SSOs

The simple framework developed in Section 3 described how the creation of new compatibility standards can influence the value of technologies used to implement them—and by extension any IPRs that "read on" those technologies. Section 4 presented some evidence that suggests that firms are becoming increasingly sophisticated in their efforts to gain a competitive advantage through the interaction of IPR strategy and participation in the standards creation process. This raises the question of how SSOs deal with the issues raised by the presence of IPR concerns in the standard setting process.

By joining an SSO, individual members incur a set of obligations that are outlined in the charter and bylaws of the organization.[xvii] The goal of these rules is to ensure that participants can make an informed decision between alternative technologies. To a large extent, the role of IPRs in the open standards creation process is governed by SSO-specific rules and procedures that can be divided into three types: search, disclosure, and licensing. Broadly speaking, these rules are designed to provide a set of procedural safeguards that will prevent SSO participants from adopting a standard that exposes them to *ex post* hold-up by patent holders offering a license that would not have been accepted in an *ex ante* negotiation.

Much of our knowledge about SSO practice comes from recent work by Lemley (2002), who surveyed the IPR policies of roughly forty SSOs. Lemley's survey found that while most SSOs with a formal IP policy have some kind of disclosure rules, relatively few require their members to conduct a search of their own files or the broader literature in order to identify relevant IPRs. The survey also revealed considerable heterogeneity in the substance of disclosure rules. The most general rule requires SSO participants to disclose any patents that they could "reasonably" be expected to know about—particularly those owned by their own employers. While this raises significant questions about what constitutes reasonable knowledge of a firm's IP portfolio (consider the different situations faced by a sole proprietor and an employee of IBM) SSOs do not typically address this issue. Most of the SSOs surveyed by Lemley required the disclosure of granted patents but not pending patent applications, in spite of the growing lag between patent applications and grant dates.

There are a number of explanations for the apparently limited use of search and disclosure rules by many SSOs. The most straightforward explanation is that these rules can impose a significant burden on SSO members and participants. This is particularly true of search rules, which may require legal skills and expertise that most of the engineers who participate in SSOs do not have. Moreover, search costs will be heavily skewed towards firms with large patent portfolios. These are often firms that the SSOs are anxious to have participants, since they can play an important role in promoting a completed standard. In addition to the concern that larger firms would respond to strict search and disclosure rules by refusing to participate, there is the possibility that they would simply provide "blanket" disclosures containing so much information that they are essentially useless. In some cases, search and disclosure rules may be weak simply because it easy for the SSO or its participants to learn about potential IP—in which case it is easy to make an informed decision without the burden associated with formal rules. Finally, the lack of strong search and disclosure rules may reflect a combination of historical bias and organizational inertia, since many SSOs adopted their rules and bylaws at a time when the economic and technological landscape was quite different. There is some evidence that a number of SSOs are responding to the various examples discussed above by updating their IPR rules.

SSOs have also sought to ensure the open-ness of their standards through licensing rules, which restrict the terms sought by SSO participants for IPR that is included in (or essential to) a compatibility standard. Licensing rules can be motivated by a number of different goals. First, they encourage adoption of the standard by offering a guarantee to potential implementers. Second, they can reduce inefficiencies and incentives to engage in rent-seeking behavior (such as the manipulation of information) in the standard setting process. Finally, they reduce the level of uncertainty inherent in the standards creation process by removing worries about pending patent applications, infringement, or the scope of granted claims.

There are essentially three types of SSO licensing rules. The most popular by far is the RAND, or "reasonable and non-discriminatory" licensing requirement. In practice, this requirement is fairly vague. While it is clear that a RAND rule implies that IPR holders cannot refuse to grant a license, it leaves them with fairly wide latitude to set prices that can even vary by licensee. Moreover, most SSOs do not actually make any determination about the "reasonableness" of a license, but rather presume that this criteria has been met as long as a license has been granted. A few SSOs, such as the W3C or some IETF Working Groups, go beyond RAND and require participants to grant a royalty-free license for any technology incorporated into a standard. Finally, there are a handful of SSOs with rules requiring patent holders to assign their IPRs to the SSO.

The fact that SSO licensing policies appear to be clustered at the "corner solutions" of RAND and royalty-free is somewhat puzzling. While RAND places a very limited set of restrictions of the SSO participants, royalty-free licensing requirements are plainly quite severe. Why haven't SSOs adopted a range of intermediate solutions, such as an *ex ante* "single-price" rule that would require a firm to commit to a single set of verifiable licensing terms before their IPR is included in a standard?[xviii] The attractiveness of RAND could come from its minimal impact on SSO participation. Stricter rules might drive organizations with large IPR portfolios out of the SSO, or even worse, lead to a standards war — although the adoption of a royalty-free policy does not appear to have had a major impact on participation in the W3C.

Another possibility is that most SSOs have adopted RAND licensing policies because they worked reasonably well in the past. Lemley found that the rules governing IP were specified in much greater detail for JEDEC and VESA—the two SSOs involved in the Dell and Rambus disputes. Moreover, there is some evidence that these recent controversies have started to have an impact. W3C and OASIS adopted royalty-free licensing policies in 2003 and 2004 respectively. While it was nearly impossible to obtain information on IPR disclosures a few years ago without going directly to individual participants, a number of SSOs have recently made their disclosure data available on the website.

A final explanation for the popularity of RAND and royalty-free licensing policies is that SSOs worry about the antitrust implications of adopting alternatives. In particular they may fear that policies leading to explicit negotiation over royalties can be construed as facilitating collusion. RAND requirements are too vague to be construed as collusive and royalty-free licenses are not an issue (since firms rarely collude to set prices at zero). The problem with this outcome from a policy perspective is that RAND leaves open the door to hold-up while royalty-free licensing rules may damage innovation incentives by preventing IPR holders from capturing the value associated with their inventions.

The strongest threat available to an SSO is to withhold or withdraw its endorsement of any standard sponsored by a firm that fails to comply with its rules. However, this will have little impact if the breach is not revealed until a specification is well on its way to becoming a *de facto* standard.[xix] Much stronger compliance incentives are created by

SSOs bylaws that contain explicit language to the effect that participants who violate search and disclosure rules forfeit their future rights to assert IP in a given standard. However, it is up to government agencies and the courts to enforce this type of rule. The legal outcomes in the Dell and Rambus cases suggest that antitrust authorities are inclined to intervene in support of SSOs when there appears to be a violation of disclosure rules. However, these cases also suggest that SSOs must be far more explicit in the construction of their own charters and bylaws if they hope to see them upheld in court.

Although the data available to answer this question are rather limited, explaining the variation in SSO IPR policies is an important and interesting topic for research. Several authors (e.g. Lerner and Tirole 2005) have speculated that much of this variation can be explained by competing between SSOs to offer an attractive standards creation environment. However, these authors seem to reach different normative conclusions. While Teece and Sherry (2003) argue that SSO competition should lead to an efficient distribution of IPR rules, Lemley (2002) concludes that, "diversity [in IPR policy] is largely accidental, and does not reflect conscious competition between different policies."

Perhaps the most interesting explanation for the exiting variation in SSO policy is offered by Cargill (2001), who suggests that SSOs have undergone a type of "organizational evolution" in response to a broader imperative for faster standards development. He suggests that the different types of SSO described at the beginning of Section 2 correspond to different phases in the history of standard setting. From this perspective, the current controversy over IPR policies is at least partly the result of the convergence of the ICT industries. The culture of open source software development is very different from that of telecommunications engineering. Both of these cultures have established a set of norms and routines that reflect the logic of the respective industries. However, they have very different ideas about the appropriate use of IPR or what constitutes a legitimately "open" standard. Cargill's thesis suggests that as the computing, telecommunications, entertainment, and information businesses continue to combine in new and unexpected ways, we will continue to see strong differences of opinion over the issue of open standards and intellectual property rights.

6. Conclusions

While there are a wide variety of different SSOs, all of them face a basic trade-off between collaboration and competition, or between open-ness and control. To analyze this tradeoff, it is crucial to understand the distinction between standards, technology, and implementations. This chapter has argued that the increasing controversy surrounding IPR strategy and policy is an indication that the tradeoff between collaboration and competition has become more. While there are several potential explanations for this increasing severity, I focused on the importance of the broad shift towards a system of open innovation. Open Innovation is characterized by increasing vertical specialization in technology and development and commercialization and has led to a proliferation of firms whose business models rely heavily on IPR because they lack access to the manufacturing and distribution capabilities required to "cooperate on standards and compete on implementation."

As the U.S. innovation system continues to evolve towards the Open Innovation model, it is important for firms in industries where standards are important to recognize the potential costs associated with their IPR strategies. In particular, aggressive IPR strategies can reduce the expected value of a standard and slow down the standards creation process. While these aggressive strategies may be perfectly legitimate from a legal perspective and strengthen (at least in theory) the incentives for small-firms to commercialize their innovations, it is important to recognize that these strategies increase the severity of the trade-off between value creation and value capture.

SSOs also need to understand how the trend towards Open Innovation potentially complicates their job of providing a forum for informed decision-making in the creation of new compatibility standards. IPR policies based on little search, vague licensing rules and lax enforcement are likely to lead to time-consuming and expensive controversies along the lines of the Rambus case. While SSOs are clearly constrained by the need to encourage participation—and potentially by competition with other SSOs—they should strive to update their IPR policies in a way that promotes transparency in the standard setting process while respecting the legitimate rights of IPR holders.

SSO IPR polices must balance the goals of providing incentives to select the best available technology (which includes encouraging participation), ensuring that the standard setting process is reasonably efficient (which includes not placing too large a burden on participants), respecting the legitimate rights of IPR holders, and encouraging widespread diffusion and implementation of the standard. In order to achieving these outcomes, SSO must ensure that participants in the standards creation process are well informed. However, they have often been reluctant to allow firms to negotiate *ex ante* commitments to licensing terms, partly because it wasn't necessary when most of the participants already had existing cross-licenses and partly because of antitrust fears. The first of these conditions has changed, and it would probably be useful for antitrust authorities to offer some type of SSO "safe harbor" guarantee to eliminate the latter concern. This would encourage SSOs to take a more active role in resolving conflicts over IPR.

Finally, there a clear need for more research into a number of the open questions raised in this chapter. For example, is there evidence for a connection between open innovation and the prevalence of IPRs in standard setting (e.g. has the growth in IPR disclosures been driven by small and/or vertically dis-integrated firms)? What is the link between SSO or firm characteristics and the choice of intellectual property rules or strategies? What is the role of competition between SSOs in shaping the standard setting environment? At a broader level, there is a great opportunity to develop a research agenda that examines the links between features of the innovation and standard setting environment, the strategies and behaviors of SSO participants, and the performance of the standards creation system. These issues have a broad significance that extends beyond the creation of compatibility standards and will potentially deepen our understanding of non-market strategy and the institutions of self-governance.

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Table 8.1: Intellectual Property Strategies in Standards Creation

Strategy	Description	Examples	Open/Closed	Transpa
IPR Contribution	Give away IPRs (royalty-free license) to promote implementation of a standard	Ethernet	Open	Yes
Defensive patent pools	Aggregate essential IPRs in the public domain to lower implementation costs	Cable Labs	Open	Yes
Open-source licensing	Require implementers to freely license any follow-on innovations	Linux, Apache, etc.	Open	Yes
Anticipatory standard setting	Create standards early to establish prior art and avoid commercial pressures	Early IETF	Open	Yes
Participatory licensing	Disclose patents in standard setting process and license to implementers	RSA cryptography patents	Closed	Yes
Ex post licensing	Conduct a search for standards-related IPR and approach implementers about licensing	Eolas vs. Microsoft BT hyperlink suit	Closed	No
Active hold-up	Participate in SSO without disclosing IPR and then pursue ex-post licensing opportunities	Rambus	Closed	No
Royalty-generating patent pools	Pool IPRs within a centrally administered licensing authority	MPEG-LA, Via Licensing	Closed	Sometim
Cross-licensing alliances	A series of bilateral cross-licenses that has the effect of patent pool	GSM Semiconductors	Usually closed	Sometim
Disclosure strategies	Using information about IPRs to influence the pace and direction of SSO deliberations	Cisco MPLS?	Open	Sometim

End Notes

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[i] The precise meaning of "open" in the context of compatibility standards is highly contested. Moreover, the meaning of "open" in this context is different from that employed by Chesbrough in Open Innovation—a point which will be elaborated below.

[ii] See, for example, IBM's patent licensing statement at http://www.ibm.com/ibm/licensing/standards/.

[iii] Indeed, the majority of SSOs continue to have so-called RAND ("reasonable and non-discriminatory") IPR policies that encourage them to take a fairly passive stance on these issues (Lemley 2002).

[iv] Although one might exclude open source developers from the definition of an SSO on the grounds that they are focused on implementations rather than standards development *per se*. However, a reasonably broad definition of SSO should make room for open source projects that are truly multilateral, consensus-based efforts to develop new technology platforms.

[v] One notable exception is Chiao, Lerner, and Tirole (2005).

[vi] The SSOs problem strongly resembles social dilemma created by issuing patents. Patents exist to provide an incentive for innovation, but once an innovation is in place the

presence of patents leads to distortions of the market. In a similar fashion, “closed-ness” can provide an incentive for firms to participate in standards development. However, once a standard is developed, society—and hopefully the SSO—would be better off it were open.

[vii] Chesbrough and Rosenbloom (2002) make a similar point about technology more generally. They argue that the value of a technology is not realized until it is commercialized through a business model.

[viii] The formal models of Farrell, Farrell and Saloner, and Simcoe (discussed above) build on this idea.

[ix] Of course, “competing on implementation” does not completely remove the incentive for firms to try and assert control over a standard—in Figure 3, a completely open standard still generates zero profits.

[x] Dell—a large firm that was well positioned to compete on implementation—eventually agreed to license its patents freely, while Rambus—a small firm specializing in technology development—fought a long and bitter court battle.

[xi] *In the Matter of Dell Computer Corporation*, 121 F.T.C. 616 (1996) *was settled by consent order, while In the Matter of Rambus Incorporated,* 121 F.T.C. Docket # 9302 remained an active adjudicative proceeding before the FTC as of mid-2005.

[xii] There is, however, a large related literature in economics on technology licensing and collaborative R&D, much of it theoretical.

[xiii] In practice, a firm that “gives away” its IPRs usually agrees to grant any implementer a royalty-free license, which may contain a number of clauses related to “reciprocity” and “grant-back” (i.e. a promise to offer the original patent holder a royalty free cross-license

for any improvement to the underlying technology). The overall impact of a royalty-free license is to place the underlying technology in the public domain.

[xiv] The development of the original Internet protocols is a good example of anticipatory standard setting (Mowery and Simcoe 2002a).

[xv] The willingness of some SSOs to adopt standards based on RSA's technology is likely due to the fact that these patents were set to expire just as public-key encryption was set to become a critical part of the Internet.

[xvi] In fact, Rambus utilized a loophole in the patent system known as a continuation filing to actively amend its pending applications, ensuring that it would own IPRs in the eventual standard (Mowery and Graham, 2004).

[xvii] For a full treatment of the contractual issues elated to organization membership, the reader is referred to Lemley (2002).

[xviii] In practice, some firms do commit to license their IP on specific terms (usually free) as part of the standards creation process. However, this is impractical in many cases—particularly when the IPR is contained in a pending patent application whose scope is highly uncertain.

[xix] Indeed, the fact pattern in the Rambus case involves an alleged failure to disclose IP followed by the creation of a JEDEC standard that probably infringed on Rambus' IP. Rather then withdraw a standard into which its members had sunk significant resources, JEDEC contended that Rambus' actions had led to a forfeit of that IP.

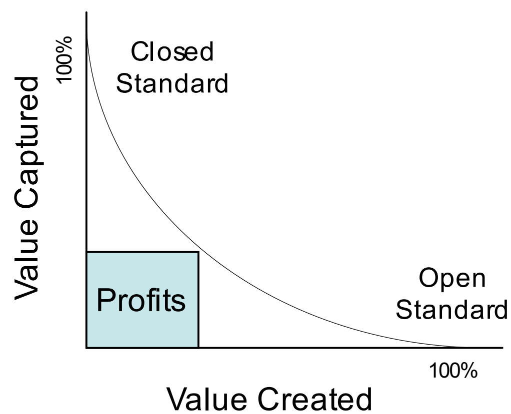

Figure 8.1: Open-ness versus control

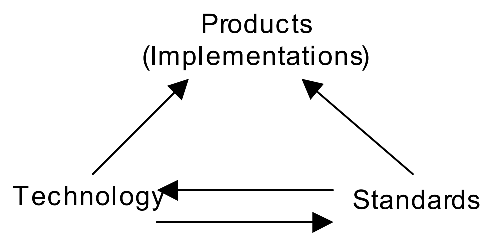

Figure 8.2: Value-drivers for Network Goods

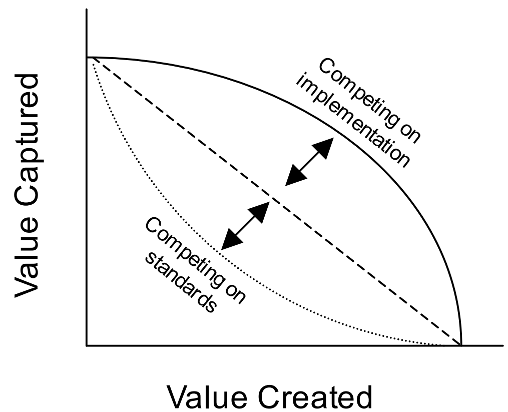

Figure 8.3: Competing on standards vs. Competing on implementation