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Licensing in the Presence of Technology Standards

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The last few decades have seen an explosion in patenting. It is now commonplace for products in information technology industries such as consumer electronics, mobile phones, and computers to use technology from hundreds, even thousands, of patents. For example, during the Macworld 2007 conference, Steve Jobs remarked that Apple had filed over 200 patents related to inventions of the new iPhone.[1] This number does not include the thousands of patents owned by other firms that have been declared essential for the iPhone to operate on wireless GSM networks, nor does it include the substantial number of additional third-party patents that the iPhone has been accused of infringing.[2]

Information technology industries tend to be industries for which technology standards are important. Technology standards come about when industry participants or government organizations define common parameters for products in an industry. They can be official standards, set by firms operating through a standard-setting organization (SSO) or they can be *de facto* standards—the result of accidents of history or unilateral actions of one or several industry participants.[3] These standards ensure compatibility of products made by different manufacturers and can provide great benefit to consumers.

Several generations of wireless communications have been governed by various standards, including GSM, CDMA-2000, and UMTS. Digital television is governed by the ATSC family of standards in North America and the DVB family of standards in Europe. For computing, the list of well-known standards includes Wireless Application Protocol (WAP), Bluetooth, and Portable Document Format (PDF).

The benefits of technology standardization can be considerable. While standards occur in a variety of industries,[4] they are more likely to be important in industries with scale economies and especially where network effects are prominent. For so-called network goods, the value a consumer obtains from consumption is enhanced when a number of other consumers purchase the same product. This enhanced value stems largely from compatibility across multiple users. A classic example of a network good is the telephone.

When technology standards are either absent or in competition, the result can be a delay in consumer adoption of products. Such a delay can be seen by looking at the standards war involving the HD-DVD and Blu-ray formats, which is widely blamed for hindering consumer adoption of these next generation devices in the United States.[5] Another example is second generation (2G) mobile phones. Europe, which had a pan-European GSM standard, experienced significantly higher growth rates in mobile phone use in the 1995 to 1998 timeframe than did the United States, where the industry was fragmented among CDMA, GSM, and TDMA standards.[6]

The increasing issuance of patents and adoption of technology standards has enabled new and profitable products, but it has also brought challenges related to intellectual property licensing and use. Two important issues arising in licensing intellectual property in the context of technological standards are (1) "patent thickets," *i.e.,* multiple patented technologies with multiple owners incorporated in a single product, and (2) "hold-up" or "lock-in," *i.e.,* the ability of the seller to exploit the absence of acceptable alternatives available to the buyer. Patent thickets and hold-up can lead to high royalty burdens, increased product costs, suboptimal adoption of technologies and, in some cases, costly litigation. Various mechanisms are available to industry participants in order to mitigate potential licensing problems, including the formation of patent pools, the adoption of certain licensing provisions such as cross-license and "royalty-stacking" provisions, and commitments to offer licenses on Fair, Reasonable, and Non-Discriminatory (FRAND) terms.

The Patent Thicket

The "patent thicket" is "a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology."[7] Patent thickets may sprout whenever multiple patented technologies are incorporated in a single product. They are particularly likely to be a problem for products subject to technological standards.

In situations where products incorporate multiple technologies, a product manufacturer may need access to intellectual property from multiple sources in order to produce a standards-compliant product. Each patent owner has, by definition, the right to exclude others from using its patented technology. The market power inherent in that right depends on whether acceptable substitute patented technologies exist. If we assume for simplicity that each of the required patented technologies is a blocking patent, *i.e.,* there are no acceptable substitutes, then each patent owner can extract a high price or license fee in exchange for use of its patented technology. If each of the multiple patent owners chooses to extract a high price, the licensee may find that the required license fees severely limit the profit potential for the product or, in the extreme, make the product commercially unviable.

In economic theory, this is referred to as the classic "complements problem" originally studied by Augustin Cournot in 1838.[8] Cournot considered the hypothetical situation faced by a manufacturer of brass who needed to purchase two key inputs, copper and zinc, each supplied by a monopolist. As he demonstrated, the resulting price of brass was higher than it would have been if a single firm were the source of both copper and zinc. A key implication of Cournot's work is that both output suppliers and input suppliers would be better off in the presence of coordinated pricing for both essential inputs. That is, a reduction in input prices would lead to a corresponding reduction in output prices spurring an increase in quantity demanded of output products. This increase in quantity demanded of output products, in turn, means increased demand for inputs with resulting increased profits for both output and input suppliers.[9] The typically-suggested solution to the complements problem is the merger of input suppliers.

A close analogy in the economic literature is the "tragedy of the anti-commons." This refers to the opposite situation from the more well-known "tragedy of the commons," the classic example of which is communal land for grazing sheep. The tragedy of the commons refers to the detrimental outcome that can occur when an asset is jointly owned by multiple parties. Because each owner lacks the right to exclude the others, the result is overuse and depletion of the underlying asset, making all owners worse off. In the case of the complements problem, the tragedy of the anti-commons is more apt. That is, the existence of multiple patent owners, each with the right to exclude others from their patented technology, leads to under-utilization of each patent owner's technology.[10]

In the case of standards-compliant products where there are a number of essential patented technologies required for the production of any one product, the inputs are the patented technologies. Relative to the classically stated two-input complements problem, the presence of multiple essential patented technologies may magnify the problem, resulting in overpricing and a reduction in quantity demanded of the output product. In the extreme, too high of a burden associated with input costs could render the product commercially unviable.

In the field of licensing, this phenomenon is often referred to as the "royalty stacking" problem. Often patents are priced as a percentage of the sales price of the patented product, and it is not uncommon for the royalty rates to be in the range of 5 percent of product sales.[11] The magnitude of the royalty stacking problem is clear in the case of a product embodying twenty essential patented technologies. A license fee of 5 percent of sales for each patented technology would consume 100 percent of the product revenues.[12]

Differences in the diffusion of intellectual property ownership across two competing wireless telecommunications standards provide real-world evidence of the complements problem in high-technology

industries. 2G wireless communications generally refers to the digital mobile phone voice technologies that were deployed in the 1990s and were dominant in developed countries until relatively recently. Most wireless communications systems operated according to one of two standards: GSM or CDMA. Each of these standards incorporates hundreds of patented technologies.[13] However, there are important differences in the distribution of intellectual property ownership across the two standards. Key 2G CDMA patents are thought to be relatively concentrated in the hands of Qualcomm. In contrast, GSM intellectual property is relatively widely held, with several large firms such as Ericsson, Nokia, Motorola, and Siemens owning multiple patents.

Consistent with the "complements problem" described above, royalty rates paid on CDMA phones are lower than the royalty rates paid on GSM phones. According to publicly-available information, CDMA license fees were approximately 5 percent; whereas cumulative license fees for GSM technology were estimated to be as high as 8.5 percent to 29 percent.[14] These differences in the concentration of intellectual property rights have persisted into the next generation 3G technologies.[15]

As shown in Exhibit 1 the share of worldwide shipments of GSM and CDMA handsets accounted for by 3G technology was substantially higher in CDMA networks than in GSM networks up through 2008. The slower adoption of 3G technology in GSM networks may be due, at least in part, to the presence of multiple patent owners and correspondingly higher royalty burdens. A patent thicket also may have contributed to the price premium on 3G GSM phones relative to their CDMA counterparts.[16]

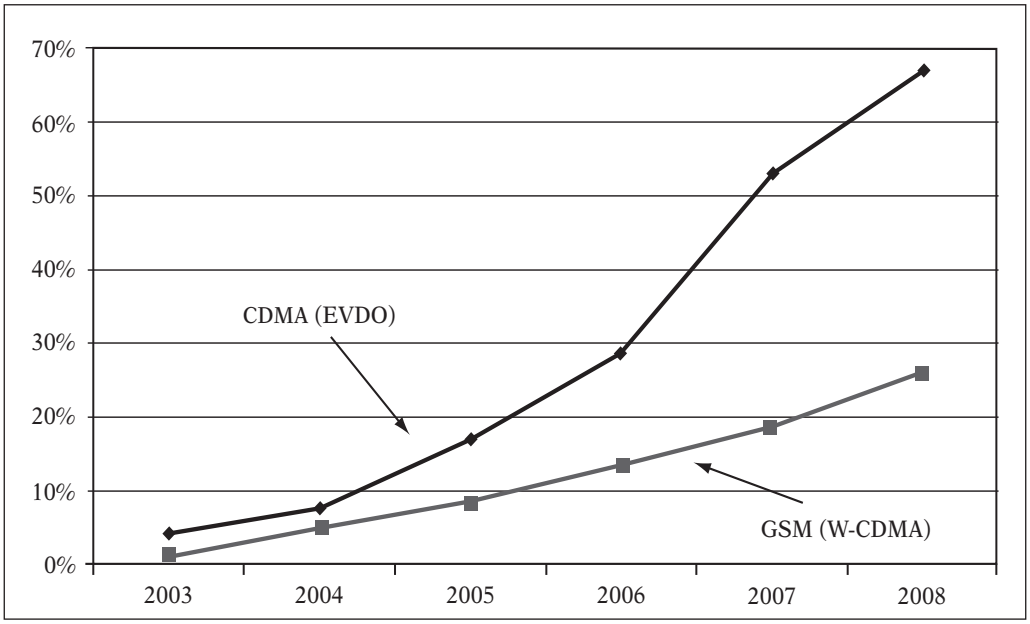
Hold-Up/Lock-In

The opportunity for "hold-up" occurs when a purchaser of a given product faces "lock-in," *i.e.,* the absence of alternatives, which results in the possibility of exploitation by the seller. The classic example of a hold-up situation is the price of a glass of water in the desert, which is inflated by the absence of readily-available alternatives.

With respect to intellectual property rights, the opportunity for hold-up can occur when one firm has invested considerably to develop a specific product and bring it to market, finding out only once it has launched that another firm owns intellectual property rights covering that product. In such a situation, the owner of the intellectual property can extract not only the value of the underlying intellectual property but additional value as a result of the manufacturer's prior investment in developing the product and bringing it to market. Thus, timing is a critical factor affecting the opportunity of hold-up.

This phenomenon is particularly applicable to licensing in the context of technological standards. Once a standard-setting body decides to incorporate a

Exhibit 1: 3G Fraction of Worldwide Shipments CDMA Networks vs. GSM Networks



Source: Data from Oppenheimer and Co., *Chasing the Carrot*, March 1, 2009.

particular patented technology into a standard, the possibility for product manufacturers to use alternative patented technologies in their standards-compliant products is eliminated. *Ex-ante*, prior to incorporation into the standard, there may have been many acceptable alternative technologies available, substantially limiting the value of the patent. *Ex-post*, however, manufacturers wishing to produce standards-compliant products have no alternative but to take a license to the patent. The resulting lock-in makes licensees vulnerable to hold-up. In a 2005 speech, Chairman of the FTC, Deborah Platt Majoras, described the issues of lock-in and hold-up as follows.

> If, at the start of the process, any one of a number of competing formats could win the standards battle, then no single format will command more than a competitive price. But standardization can change that dynamic. After the standard is chosen, industry participants likely will start designing, testing, and producing goods that conform to the standard—that is, after all, the whole idea of engaging in standard setting. Early in the standardization process, industry members might easily be able to abandon one technology in favor of another. But once the level of resources committed to the standard rises and the costs of switching to a new technology mount, industry members may find themselves locked into using the chosen technology. In that case, competition for the standard ends (at least for a time, until, for example, the next generation of technology supplants it).[17]

In some cases, owners of standards-essential intellectual property have been accused of lobbying for inclusion of their patented technologies in standards while simultaneously failing to disclose the existence of such patents to SSOs in order to exploit the benefits of lock-in once their technologies are incorporated into the standard. Two notable examples involve Dell Computer Corp. and Rambus, Inc.[18]

In 1992, the Video Electronic Standards Association (VESA) created a standard for a VL-bus, a mechanism to transfer instructions between a computer's central processing unit and its peripherals. Dell, a member of VESA, certified that it had no patents essential to the standard. However, shortly after adoption of the standard, Dell asserted its patents against firms that followed the VESA standard. After being sued by the U.S. Federal Trade Commission (FTC) for unreasonably restraining competition, Dell agreed not to assert its VESA-related patents.

In the early 1990s, Rambus was a member of JEDEC, a standards-setting body in the semiconductor industry. While JEDEC was developing a standard for SDRAM, Rambus failed to disclose that it owned, and was applying for additional, patents that could be enforced against JEDEC-compliant products. After withdrawing from JEDEC, Rambus sought to enforce its patents. Years of litigation involving Rambus, other semiconductor industry participants and the FTC have ensued.

Mechanisms to Address Patent Thicket and Hold-Up

The patent thicket can exacerbate the hold-up problem. In the case of a standards-compliant product embodying multiple standards-essential patented technologies, each patent owner can extract a disproportionate share of manufacturer's profits, as each patent is essential to product manufacture. The impact of such excessive royalty demands can be higher prices leading to a reduction in quantity demanded and delays in technology adoption. A variety of mechanisms have been proposed to address these issues. This article discusses three types of mechanisms: (1) patent pools; (2) licensing provisions such as cross-licensing and royalty-offset provisions; and (3) FRAND commitments.

Patent Pools

One approach to mitigating the problems of patent thickets and hold-up is the formation of patent pools. A patent pool involves a group of intellectual property owners agreeing to combine or "pool" all of their standards-essential patents and license the patents to each other and to third parties for specified rates. Such arrangements were relatively common from the latter half of the 19th century through the early part of the 20th century but basically disappeared in the 1950s due to antitrust concerns.[19] Since the mid-1990s, patent pools have made a comeback, with recent and proposed patent pools for technologies such as DVDs, mobile communications, audio and video compression, and radio frequency identification (RFID). (*See* Exhibit 2.)

A patent pool is an agreement among multiple firms to offer a single license to the essential patents incorporated into the standard to all those willing to pay specified license fees. Thus, the mechanism is well suited to deal with patent thickets, as it transforms a situation with multiple patent licensors susceptible to the complements problem into one in which a single entity licenses the multiple complementary patents.

Exhibit 2: Selected Patent Pools

Patent Pool	Technology Area	Origination Date	Sources of Information
DVD6C Licensing Agency	DVDs	1999	http://www.dvd6cla.com
DVD3C Licensing Group	DVDs	1998	http://www.ip.philips.com; http://www.usdoj.gov/atr/public/busreview/2121.htm
MPEGLA MPEG-2 Patent Portfolio License	Video Compression	1997	http://www.mpegla.com
W-CDMA Patent Licensing Programme	3G Wireless Communications	2004	http://www.3glicensing.com/; http://www.usdoj.gov/atr/public/busreview/200455.pdf
Bluetooth Special Interest Group	Short range Wireless Communications	1997	http://bluetooth.com
Voice Age –AMR-WB+	Audio Codec	2004	http://www.voiceage.com/licamrwbplus.php
IEEE 1394	High Speed Digital Transfer	1999	http://www.mpegla.com/1394/
AVC/H.264	Digital Video Coding	2004	http://www.mpegla.com/avc/
Green Fluorescent Protein	Medical Research	2001	http://www.law.washington.edu/Casrip/Summit/2005/Goldstein/ppt
Open Patent Alliance	WiMax 4G Wireless Communications	Proposed	http://www.openpatentalliance.com/
UHF-RFID Patent Licensing Program	Automatic identification and data capture technology	Proposed	http://www.rfidlicensing.com/
LTE	4G Wireless	Proposed (May 2009)	http://www.vialicensing.com/patent/LTE_index.cfm

Other benefits of patent pools include a reduction in transaction costs because of a decrease in the number of independent license agreements that must be negotiated, a reduction in licensing uncertainty, and a decrease in litigation risks. Patent pools also can be effective in limiting the opportunity for hold-up. The commitment by patent holders to license a pool of all of their essential intellectual property at specified rates, along with typically-included provisions requiring licensees to grant rights to their standards-essential patents back to the patent pool, severely limits the ability of any one patent holder to exploit lock-in and charge excessive license fees.

Among the main deficiencies of patent pools in dealing with patent thickets and hold up is that participation is voluntary. The incentives to join patent pools will depend on the benefits that firms obtain from joining and from the costs of participation. These benefits and costs depend on factors such as: the number and diffusion of standards-essential patents; the number of potential licensees; the overall royalty rate of the patent pool; the formula used to allocate royalties among patent holders; and the position of the firm in the supply chain.[20]

Any firm deciding whether to join a patent pool will be particularly concerned with the following: the size and quality of its patent portfolio; the overall royalty rate; and the formula used to allocate collected royalties to the patent owners. For firms that own the most valuable patents, the transaction-cost savings of

patent pool participation may not be worth the loss in licensing revenues.

Several existing patent pools involve enough licensors, patents, and licensees to serve as a useful antidote to the patent thicket problem. A description of selected features of four existing and proposed pools is contained in Exhibit 3. One example is the DVD6C patent pool, which involves 9 licensors, 302 licensees, and 4,922 patents. Another notable aspect of the DVD6C patent pool is its modest per-patent license fees. For example, for sales of DVD video recorders, the 4 percent royalty rate is split among the essential 634 US patents and results in a per patent royalty rate of less than 0.01 percent of the sales price of each video recorder.[21] As demonstrated by the MPEG-2 and W-CDMA pools, the license fee can be specified on a per-unit basis, and, as is the case with the Bluetooth patent pool, a patent pool can be royalty free.

However, the voluntary nature of patent pool participation can undermine even a well-subscribed patent pool. The W-CDMA and proposed RFID patent pools provide an illustration of this. Despite comprising 296 patent families, contributed to by 12 licensors, the W-CDMA pool does not include the patents of many of the most prominent patent holders in the area including Ericsson, Motorola, Nokia, and Qualcomm.[22] The proposed RFID patent pool consists of six patent holders and 10 essential patents, but does not include any patents owned by Intermec, which is thought to be a significant holder of essential patents in the area.[23]

For all four of the patent pools shown in Exhibit 3, the apportionment formulas are based, at least partly, on the proportion of patents contributed by each firm. In the case of the W-CDMA licensing program, the allocation rule is "equal compensation for each essential patent," while for the proposed RFID pool, half of the collected royalty amount is allocated based on the number of patents contributed by each participant, and the other half is allocated "substantially equally among participants." The apparent simplicity of the apportionment formulas in patent pools suggests that the most valuable patents may be under compensated. This may help explain why certain firms decline to participate.

Even where a pool does not offer all of the patents that are necessary to manufacture standards-compatible products, it can still reduce the transactions costs related to licensing of standards-essential technology. In addition, as recognized by the US Department of Justice in a recent business review letter related to the proposed RFID patent pool, "*Overall Royalty Rates May Be Lowered by Limiting the Threat of Hold-up and Royalty Stacking*."[24]

Licensing Provisions

There are a number of contractual mechanisms for parties to address the twin problems of the patent thicket and hold-up. This discussion focuses on two types of license provisions that are prevalent in licenses involving technology incorporated in

Exhibit 3: Features of Selected Patent Pools

	Licensors	Patents	Licensees	Royalty Rate	Royalty Apportionment
DVD6C Licensing Agency	9	4922	302	$0.04 for most discs; greater of 4.0% of selling price or $3 for most players or drives	Based on how often a licensor's patent are infringed and the age of the patents.
MPEGLA MPEG-2 Patent Portfolio License	20	772	67	$2.50 /unit for consumer products; $0.01 to $0.08 /unit for packaged media.	Based on each licensor's share of the product.
W-CDMA Patent Licensing Programme	12	296 families	N/A	$1.00 to $2.00 per handset.	Equal compensation for each essential patent
UHF-RFID Patent Licensing Program	6	10	–	–	Half of the royalties are allocated based on the number of patents, and the other half are allocated substantially equally among participants.

industry standards: (1) cross-licensing provisions; and (2) royalty-offset provisions.

Cross-licensing provisions involve mutual exchange of intellectual property rights by patent holders and licensees. These types of provisions are especially common in industries in which multiple patent owners hold rights to standards-essential intellectual property *e.g.*, the computer industry.[25] In such cases, product manufacturers holding their own portfolio of standards-essential patents, which are necessary, but not sufficient for the manufacture of standards-compliant products, agree to a mutual license grant to ensure that each has the freedom to operate in the field at issue. In many instances, these cross-licenses provide for the royalty-free exchange of patent rights. In other cases, in which there is an asymmetry in the value of one parties' patent rights relative to another, these licenses may provide for ongoing royalties or balancing payments to be paid by the party with the lesser-value portfolio.

Although cross-licensing provisions are employed successfully in many instances, they are of limited use in other cases, such as when one of the parties is a non-practicing entity. In such a situation, the non-practicing entity will derive no benefit from a cross-license provision in which it obtains the rights to the other parties' proprietary intellectual property. Similarly, when one party operates at a different level of the distribution chain than another, cross-license provisions may be more difficult to employ.

Another mechanism that is often employed in licensing—involving industries in which products tend to embody multiple patented technologies—is a royalty-offset provision.[26] Royalty-offset provisions involve reductions in per-patent royalties to limit the overall royalty burden on the product. These provisions are particularly common in the pharmaceutical industry as well as in other high-technology industries.

Royalty-offset provisions can involve specific license terms which provide for percentage reductions in royalties in the event that the licensee is also required to pay license fees to a third-party for the rights to additional essential intellectual property rights. Such provisions can provide the licensee a discount of 25 to 50 percent of the specified royalty rate in the event that the cumulative royalty burden on the product exceeds a particular maximum.

Royalty-offset provisions also can more generally describe discounted rates for a firm's entire portfolio of patents. One well-known example of an effort by a patent holder to take into account the potential negative effects of royalty-stacking in industries with products incorporating multiple patented technologies is the IBM licensing policy. For many years, IBM offered its intellectual property at the published rate of one percent per patent up to a cumulative maximum of 5 percent for its entire portfolio. Given that IBMs patent portfolio at the time included approximately 10,000 patents, a portfolio license for 5 percent resulted in a substantial per patent discount.[27]

By reducing the royalty rate when multiple patents are required, royalty-offset provisions represent an effort to contractually address the complements problem previously described. While royalty-offset provisions can be useful in some circumstances, they are of more limited use when there are a large number of intellectual property owners claiming rights on technology embodied in a specific product.

FRAND Commitments

Another mechanism for addressing issues arising in the context of licensing patented technology incorporated into industry standards is the use of FRAND commitments. FRAND commitments are agreements by patent holders to license technology that is essential to practicing a standard to all comers at license fees that are fair, reasonable, and nondiscriminatory.[28] FRAND commitments can be a way to limit the ability of a patent owner to exploit the lock-in associated with incorporation of its patented technology into the standard.

Most standard setting organizations require contributors of intellectual property to the standard to agree to license their patents on FRAND terms. For example, according to the European Telecommunications Standards Institute (ETSI) rules associated with standard-setting, each ETSI member commits to use reasonable efforts to disclose all intellectual property rights (*i.e.,* patents) that it owns which might be essential to the proposed standard and, further commits to license those patents on FRAND terms. If the patent holder is not willing to enter into this FRAND commitment, then ETSI reserves the right to suspend work on the standard and search for viable alternative technologies for incorporation into the standard.

Unfortunately, although FRAND commitments are widely used by standards setting organizations, the precise interpretation of a FRAND commitment is not widely agreed upon. From an economic perspective, a FRAND commitment implies, at a minimum, an agreement to license all comers. This can have important implications for patent infringement litigation, in that it may preclude two common remedies: (1) awards of lost profits and (2) injunctions.[29]

The *non-discriminatory* aspect of FRAND means that all similarly situated licensees should be offered

similar terms by essential patent holders. Importantly, from an economic perspective, it does not mean that specific terms of licenses involving different parties will be identical. Typical reasons for differences may include sales volume, creditworthiness and the amount of intellectual property included in a cross license. Because licenses and licensees can vary in several dimensions, discriminatory licensing practices are not always easily identifiable. We are aware of a number of disputes involving accusations of discriminatory licensing practices in violation of FRAND commitments. For example, in the recently-settled *Broadcom v. Qualcomm* antitrust litigation, Broadcom asserted that Qualcomm had violated its FRAND commitment, at least in part, because it allegedly charged higher rates for its patented technologies to cellular handset manufacturers who purchased the chips of rival firms than to firms who purchased Qualcomm's chips.

Perhaps the most contentious aspect of FRAND commitments involves the interpretation of "reasonable" or "fair and reasonable." The contentiousness of this issue is evidenced by the substantial amount of litigation in this area. This was a central issue in the recently-settled litigations between Broadcom and Qualcomm and between Nokia and Qualcomm, with Broadcom and Nokia arguing that Qualcomm's offers to license its standards-essential patents were not consistent with honoring its FRAND obligations.[30] As well, in ongoing litigation between Motorola and RIM, RIM has alleged that Motorola's offers to license its wireless communications technology patents are inconsistent with its FRAND commitment.[31]

Below, are discussed three types of approaches to the determination of FRAND royalty rates: (1) approaches based on explicit economic models, (2) *Georgia-Pacific* factor analysis; and (3) numeric proportionality. These approaches can provide some guidance in analyzing the implications of the FRAND commitment on license terms, from both a theoretical and a practical point of view.

Economic Models

Economic approaches to valuation emphasize that, fundamentally, the value of a patent should be determined by the marginal contribution of the patented technology to the products that incorporate it. One key to determining the marginal value of a patented technology is the extent to which it provides benefits over the use of alternative technologies.

In analyzing the value of a patented technology incorporated in a standard, economists emphasize that it is important to isolate the inherent value of the patented technology from the value conveyed by its incorporation into a standard. Economists tend to agree that, in theory, "reasonable" should mean the license fee that a patent holder could obtain in open competition with alternative technologies, *i.e.*, in the absence of hold-up due to lock-in.[32] This idea of "reasonable" is related to the medieval ethical concept of "just price," where, for example, the "just price" of a horse was the price that could be obtained on the open market, not the price that could be obtained by a traveler in desperate need.[33]

In a 2007 paper, Layne-Farrar, Padilla, and Schmalensee focus on two alternative approaches to the determination of FRAND royalties grounded in economic theory.[34] The first is an auction model rooted in the concept of market competition and economic efficiency. The second is an approach based on cooperative game theory.

The auction model framework is based on a 2005 paper by economists Daniel Swanson and William Baumol in which the authors posit that FRAND royalty rates should approximate the outcome of an ex-ante (i.e., prior to standard setting) auction process, which allows for competition between all patents considered for inclusion in a standard based on both their technological merit and the licensing terms offered.[35] In their view, the results of such an ex-ante auction provide a reasonable benchmark for what is fair, reasonable and non-discriminatory ex-post.

The second approach is based on the application of a game theoretic approach originally proposed in the 1950s by Lloyd Shapley. The Shapley value approach focuses on the ex-ante division of rents among patented technologies potentially incorporated in a standard. The intuition behind the Shapley value is straightforward. The value of each patent incorporated in a standard is equivalent to the incremental value that the patent brings to the standard relative to alternative technologies.[36]

While these models are rooted in different economic concepts, some common principles emerge.

- The value of a patented technology is critically dependent on the availability of acceptable alternatives.
- The FRAND commitment implies *ex-ante* (*i.e.*, before standard setting) consideration of the scope of available alternatives.
- The royalties commanded by a patent that has an imperfect substitute should be no greater than the marginal benefit it brings to the output products relative to the close substitute. For example, if the use of patent A vs. patent B in a standard means that the same number of output products would

be sold for $1 more, then the per unit royalty for patent A should be no greater than $1.

- A patent with many close substitutes on an ex-ante basis should command a very limited royalty. The greater the number and acceptability of alternatives the closer the royalty should be to zero.

While economic models do not provide an explicit formula for the determination of FRAND license fees, they can provide a useful guiding framework. Economic theory suggests that an appropriate interpretation of a FRAND commitment involves the analysis of the value of the subject intellectual property *prior* to when a standard is set, *i.e.,* on an *ex-ante* basis. Such *ex-ante* determination allows for the possible substitution of alternative technologies and eliminates the lock-in associated with incorporation of a particular technology into a standard.

Georgia-Pacific Factor Analysis

A 1970 United States District court decision in the *Georgia-Pacific v. U.S. Plywood* case has had a lasting impact on the law governing reasonable royalty determination in litigation.[37] In that decision, the court enumerated 15 factors that it found to be relevant to the determination of a reasonable royalty in exchange for the rights to the patent-in-suit. While the factors themselves are not derived from an explicit economic model, they can be thought of as a practical exposition of many economic factors that can affect the outcome of licensing negotiations.[38] Exhibit 4 provides a list of the *Georgia Pacific* factors.

Consideration of each of these factors is useful in analyzing the likely outcome of a hypothetical negotiation between patent holder and would-be licensee. The importance of each individual factor can vary considerably depending on facts specific to the negotiation such as: whether there is an established royalty for the patent-in-suit; the typical licensing policies and practices of licensor and licensee; whether the licensor and licensee are direct competitors, the extent to which a license to the patented technology can lead to sales of ancillary products; the profitability of the products embodying the patented technology and the contribution of the patented technology to those products.

Consideration of the *Georgia-Pacific* factors also can provide useful insight in determining reasonable license fees for patents incorporated in technological standards. While each of the factors may be relevant to such a situation, there are a number of factors that would be expected to have particular relevance in the case of licensing in the context of standards, including Factors 4, 9, 10, and 13.

> Factor #4: The licensor's established policy and marketing program to maintain his patent monopoly by not licensing others to use the invention or by granting licenses under special conditions designed to preserve that monopoly.

Factor 4 involves a consideration of whether the licensor has an established policy of licensing its patented technology, or maintaining a patent monopoly. With respect to licensing in the context of technological standards and in the presence of a FRAND commitment, a licensor has explicitly agreed to license its technology to all potential licensees, which means it has agreed to forego its patent monopoly in exchange for incorporation into the standard.

> Factor #9: The utility and advantages of the patent property over the old modes or devices, if any, that had been used for working out similar results.

> Factor #10: The nature of the patented invention; the character of the commercial embodiment of it as owned and produced by the licensor; and the benefits to those who have used the invention.

Factors 9 and 10 have to do with the nature of the patented technology and its benefits over alternative technologies. In the presence of a FRAND commitment, it is appropriate to examine the acceptability and availability of alternatives to the patented technology on an *ex-ante* basis, *i.e.,* prior to standard setting. Failure to do so could result in the appropriation by the patent holder of value conveyed by the standard itself, rather than value conveyed by the patent alone.

> Factor #13: The portion of the realizable profit that should be credited to the invention as distinguished from non-patented elements, the manufacturing process, business risks, or significant features or improvements added by the infringer.

Factor 13 considers the importance of the patented technology to the product as-a-whole. As mentioned previously, standards-compliant products tend to embody multiple patented technologies, and, thus, careful consideration of the contribution of the specific patent-at-issue is particularly important.

Numeric Proportionality

A number of participants in industry standards have advocated numeric proportionality as the most appropriate way to implement FRAND licensing in

Exhibit 4: Georgia-Pacific Factors

1.	The royalties received by the patentee for the licensing of the patent-in-suit, proving or tending to prove an established royalty.
2.	The rates paid by the licensee for the use of other patents comparable to the patent-in-suit.
3.	The nature and scope of the license.
4.	The licensor's established policy and marketing program to maintain his patent monopoly.
5.	The commercial relationship between the licensor and licensee.
6.	The effect of selling the patented specialty in promoting sales of other products of the licensee.
7.	The duration of the patents and the term of the license.
8.	The established profitability of the product made under the patent; its commercial success; and its current popularity.
9.	The utility and advantages of the patent property over the old modes or devices, if any, that had been used for working out similar results.
10.	The nature of the patented invention; the character of the commercial embodiment of it as owned and produced by the licensor; and the benefits to those who have used the invention.
11.	The extent to which the infringer has made use of the invention; and any evidence probative of the value of that use.
12.	The portion of the profit or of the selling price that may be customary in the particular business or in comparable businesses to allow for the use of the invention or analogous inventions.
13.	The portion of the realizable profit that should be credited to the invention.
14.	The opinion testimony of qualified experts.
15.	The amount that a licensor and a licensee would have agreed upon if both had been reasonably and voluntarily trying to reach an agreement; that is, the amount which a prudent licensee—who desire, as a business proposition, to obtain a license to manufacture and sell a particular article embodying the patented invention—would have been willing to pay as a royalty and yet be able to make a reasonable profit and which amount would have been acceptable by a prudent patentee who was willing a grant a license.

Source: *Georgia-Pacific Corporation v. United States Plywood Corporation,* 318 F. Supp. 1116, (S.D.N.Y., 1970).

practice. In simple terms, numeric proportionality requires that each patent owner contributing to a technology standard receive a share of total royalties in proportion to that owner's share of essential patents.[39] If such a method is relatively simple, it also is quite controversial, and its place in determining FRAND royalty rates was debated vigorously in relation to a series of legal disputes between Nokia and Qualcomm that were settled in mid-2008.[40]

The main advantage of the numeric proportionality approach is the simplicity and ease of implementation, which results in reduced transaction costs. In addition, there is some precedent in that the allocation formulas used in patent pools are often based on variations of numeric proportionality.

Detractors point out several problems with using numeric proportionality in determining FRAND license fees. First and foremost, implementation of

this approach relies critically on the identification of *essential* patents. This can be a less than straightforward exercise. SSOs typically request that organization members make declarations of essentiality, but do not always conduct independent assessments of whether patents are truly essential to the practice of the standard. Given that failure to disclose an essential patent to an SSO may lead to a loss of enforcement rights, patent holders have an incentive to over-declare essential patents. A real-world example of the potential for over-declaration may be seen by comparing the 436 patents determined to be essential by the 3G Licensing Programme to the 764 patents that the twelve members of that patent pool have declared as essential to ETSI in relation to UMTS.[41]

Another central critique of numeric proportionality is that not all patents are equally valuable. Indeed, economic studies have shown that patent values are skewed with a majority of issued patents having little or no value and a small minority having considerable value.[42] A number of studies have been done that attempt to infer patent value based on a number of other metrics such as: number of citations, family size, scope of geographic coverage, etc. Thus, simple patent counts might be improved by weighting patents according to value along these and other dimensions.

Conclusion

The increasing prevalence of patents, network goods, and technology standards has brought with it licensing complications such as patent thickets and hold-up. Patent thickets and hold-up can have detrimental consequences such as increased product prices and delayed technology adoption. This article has discussed how several mechanisms can be employed to address such complications. These mechanisms include the formation of patent pools, contract provisions such as cross-licensing and royalty-offset provisions as well as FRAND commitments. Each of these mechanisms is currently used to facilitate licensing in the context of technology standards.

FRAND commitments frequently are required by SSOs in exchange for incorporation of a patent owner's technology into a standard. While such a commitment theoretically addresses the problems associated with multiple patents and lock-in, in practice FRAND commitments may be difficult to enforce. The enforcement difficulties arise from the lack of clarity surrounding the impact of a FRAND commitment on license fees for patents incorporated in technology standards. We have discussed three possible methods for determining FRAND royalties: approaches based on economic models, use of the landmark Georgia-Pacific factors, and application of numeric proportionality. Each of these methods used alone or in combination can provide useful guidance in interpreting the impact of a FRAND commitment on appropriate license fees to be charged by the owner of a patent incorporated in a technology standard.

1. *See http://www.engadget.com/2007/01/09/live-from-macworld-2007-steve-jobs-keynote/* (viewed May 21, 2009).
2. A review of the litigation news suggests that Apple, via its iPod, has been accused of infringing patents whose rights are owned by WiAV Solutions LLC, Elan Microelectronics Corp, EMG Technology LLC, Picsel, Affinity Labs, and Accolade Systems LLC.
3. For example, the Wintel (or PC compatible) computing platform is a *de facto* standard that came about after several years of competition between and coordination of several computing and technology firms.
4. In all, according to the American National Standards Institute (ANSI), there are at least 200 standard setting organizations in the United States, overseeing more than 10,000 national standards. *See http://www.ansi.org/about_ansi/introduction/introduction.aspx?menuid=1*(viewed May 21, 2009).
5. "Warner: DVD format war hurt movie sales," *CNNMoney.com*, Jan. 7, 2008.
6. *See, e.g.*, "The Cell Phone as A Handheld Miracle," *Business Week,* Jul. 13, 1998, *http://www.businessweek.com/archives/1998/b3586149.arc.htm.*
7. Carl Shapiro, "Navigating the Patent Thicket: Cross Licenses, Patent Pools and Standard Setting," 2001 *Innovation Policy and Econ*. 120.
8. *Id*. 123.
9. For a translated version of Cournot's 1838 work, *see* A. A. Cournot, *Researches into the Mathematical Principles of the Theory of Wealth*, The MacMillan Company (1897).
10. Michael A. Heller & Rebecca S. Eisenberg, "Can Patents Deter Innovation? The Anticommons in Biomedical Research," 280 *Sci*. 698 (1998).
11. Martin S. Landis, "Pricing and Presenting Licensed Technology," *The Journal of Proprietary Rights*, 3, 8, (1991).
12. Some economists have argued that while royalty-stacking in industries with technological standards exists in theory, the practical impact is limited. *See, e.g.,* Damien Geradin, Anne Layne-Farrar & A. Jorge Padilla, "The Complements Problem within Standard Setting: Assessing the Evidence on Royalty Stacking," *Boston University Journal of Science and Technology Law*, 14, 2, (2008).
13. *See, e.g.,* Analysis of Patents Declared as Essential to GSM as of Jun. 6, 2007, Fairfield Resources International, (2007), available at *http://www.frlicense.com/GSM_FINAL.pdf*.
14. *See, e.g.,* Michael Ounjian, et al., "3G Economics Update," *Credit Suisse*, Mar. 26, 2007; Shailendra Pandey & Stuart Carlaw, "Mobile Handset Royalties, Intellectual Property Rights Analysis for GSM, CDMA, WCDMA, HSDPA, LTE, WiMAX and UMB Devices," *ABI Research*, 1Q2007; Lucas van Grinsven, "Nokia says patent row to determine wireless future" (Nov. 30, 2006), available at *http://www.stepstrategy.net/artman/publish/printer_2490.shtml* (viewed May 29, 2008).
15. According to research performed by David Goodman and Robert Myers, as of 2004, Qualcomm owned almost two-thirds of *declared* essential CDMA-2000 patent families and about half of *judged* essential CDMA-2000 patent families. For W-CDMA, no firm owned more than 38 percent of the declared essential patent families and 26 percent of the judged essential patent families. David Goodman & Robert Myers, "3G Cellular Standards and Patents," *IEEE WirelessCom* (2005).
16. According to an August 2006 report prepared by the CDMA Development Group, the average sales prices of low end 3G CDMA handsets were less than half those of low end W-CDMA handsets. CDMA Development Group, "The Smart Money Is On 3G The accelerating migration to 3G technologies," Aug. 2006, available at *http://www.cdg.org/technology/3g/resource.asp*.
17. Deborah Platt Majoras, Chairman, Fed. Trade Commission, "Recognizing the Procompetitive Potential of Royalty Discussions in Standard Setting, Remarks at Conference on Standardization and the Law: Developing the Golden Mean for Global Trade," Stanford Univ. (Sept. 23, 2005), available at *http://www.ftc.gov/speeches/majoras/050923stanford.pdf*.
18. *See, e.g.,* United States Federal Trade Commission, FTC Finds Dell Corporation Restricted Competition by Failing to Disclose Patent Rights in Standard-Setting Process(In Re: Dell Corporation, Docket No. C-3658, File No. 931 0097), Jun. 17, 1996; Rambus Inc., FTC Docket No. 9302,

Opinion of the Commission, 3 (Aug. 2, 2006), available at *http://www.ftc.gov/os/adjpro/d9302/060802commissionopinion.pdf*.

19. Josh Lerner, Marcin Strojwas, & Jean Tirole, The Design of Patent Pools: The Determinants of Licensing Rules (2005).
20. For a discussion of the calculus of patent pool participation, *see* Anne Layne-Farrar & Josh Lerner, "To Join or Not to Join: Examining Patent Pool Participation and Rent Sharing Rules," 2008, available at *http://ssrn.com/abstract=945189*.
21. Calculated from information at *http://www.dvd6cla.com/*.
22. The proposed 4G WiMax patent pool has not yet received the backing of these four firms either.
23. *See http://www.rfidjournal.com/article/print/1786*.
24. *http://www.usdoj.gov/atr/public/busreview/238429.htm*. (viewed May 21, 2009).
25. *See, e.g.*, Martin Landis, "Pricing and Presenting Licensed Technology," *The Journal of Proprietary Rights*, Aug. 1991.
26. Royalty-offset provisions can also be referred to as royalty-stacking provisions.
27. Richard Razgaitis, Early-Stage Technologies: Valuation and Pricing, 1999, p. 61.
28. The acronym FRAND is more widely use in international standard setting bodies; whereas, in the United States, RAND is more commonly used. In this article we do not draw a distinction between the two.
29. In its dispute with Qualcomm, Nokia argued that Qualcomm's FRAND undertakings precluded it from seeking injunctive relief except in extraordinary circumstances. *http://www.nokia.com/NOKIA_COM_1/Press/Legal_News_(IPR_news)/IPR_News/Latest_News/Redacted-Public_Nokia_Opening_Pretrial_Brief.pdf* (viewed May 21, 2009).
30. *See, e.g., http://www.broadcom.com/press/release.php?id=726224*; *http://www.nokia.com/NOKIA_COM_1/Press/Legal_News_(IPR_news)/IPR_News/Latest_News/Redacted-Public_Nokia_Opening_Pretrial_Brief.pdf* (viewed May 21, 2009).
31. *See, e.g., http://www.law360.com/articles/47392*.
32. *See* Anne Layne-Farrar, A. Jorge Padilla & Richard Schmalensee, "Pricing Patents for Licensing in Standard Setting Organizations: Making Sense of FRAND Commitments," 74 *Antitrust L.J.* 671 (2007).
33. Carl Shapiro & Hal R. Varian, *Information Rules*, 241 (1999).
34. Anne Layne-Farrar, A. Jorge Padilla & Richard Schmalensee, "Pricing Patents for Licensing in Standard Setting Organizations: Making Sense of FRAND Commitments," 74 *Antitrust L.J.* 671 (2007).
35. Daniel G. Swanson & William J. Baumol, "Reasonable and Nondiscriminatory (RAND) Royalties, Standards Selection, and Controls of Market Power," 73 *Antitrust Law Journal* 1, 5 (2005).
36. The incremental contribution of the patent is analyzed over all possible arrival sequences resulting in an average marginal contribution.
37. *See* Georgia-Pacific Corp. v. United States Plywood Corp., 318 FSupp 1116, 6 U.S.P.Q. 235 (SD NY 1970).
38. *See, e.g.,* Stephen Degnan and Corwin Horton, "A Survey of Licensed Royalties," *les Nouvelles*, Jun. 1997.
39. This method assumes that the optimal total level of royalties associated with all of the patent rights embodied in the technology standard is known.
40. *See, e.g.*, David Goodman & Robert Myers, "3G Cellular Standards and Patents," *IEEE WirelessCom* (2005); Donald Martin & Carl De Meyer, "Patent Counting, A Misleading Index of Patent Value: A Critique of Goodman & Meyers and its Uses," (2006).
41. The over-declaration issue is also discussed in David Goodman & Robert Myers, "3G Cellular Standards and Patents," *IEEE WirelessCom* (2005).
42. *See, e.g.,* Jean O., Lanjouw, Ariel Pakes & Jonathan Putnam, "How to Count Patents and Value Intellectual Property: The Uses of Patent Renewal and Application Data," *The Journal of Industrial Economics*, December, XLVI, 4, (1998).

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