EXPANDING THE BOUNDARIES OF INTELLECTUAL PROPERTY

INNOVATION POLICY FOR THE KNOWLEDGE SOCIETY

Edited by

ROCHELLE COOPER DREYFUSS

DIANE LEENHEER ZIMMERMAN

HARRY FIRST

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SETTING COMPATIBILITY STANDARDS: COOPERATION OR COLLUSION?

CARL SHAPIRO*

We live in a world built on product standards. You can make sense of these words because we share a common language. I can fax you this chapter because our fax machines obey a common protocol. I can (probably) share computer files with you because our computers employ various standardized hardware and software formats. And I can e-mail you the file containing this chapter because of an intricate web of standardized Internet protocols. A great deal of the information economy is driven by standards.

The need for product standards is not new. In biblical times the lack of a standardized language wreaked havoc at the Tower of Babel. The US Constitution called for Congress to establish a system of standard weights and measures. During the US Civil War, the Navy managed to standardize the diameters for bolts, nuts, and screw threads, but only at Navy yards. More recently, during the great Baltimore fire of 1904, fire fighters called in from neighboring cities were unable to fight the blaze effectively because their

* Transamerica Professor of Business Strategy, Haas School of Business, and Professor of Economics, University of California at Berkeley. Portions of this chapter rely heavily on my joint paper with my colleague Michael L. Katz, *Antitrust in Software Markets*, in COMPETITION, CONVERGENCE AND THE MICROSOFT MONOPOLY (Kluwer 1999), which can be obtained at http://haas.berkeley.edu/~shapiro/software.pdf. This chapter also draws on Chapter 8 of my book with HAL R. VARIAN, INFORMATION RULES: A STRATEGIC GUIDE TO THE NETWORK ECONOMY, see www.inforules.com.

hoses would not fit the Baltimore hydrants. The following year, national standards for fire hoses were adopted.[1]

Standards are an inevitable outgrowth of *systems*, whereby *complementary products work in concert to meet users' needs*. Systems are all around us. Communications systems are a prominent example. For the language 'system' to work requires that individuals seeking to communicate learn the same language; my training in English is complementary with your training in English, but not with your training in Italian. Likewise, my fax machine or modem is complementary with your fax machine or modem if they utilize the same transmission and compression protocols. Happily enough, the International Telecommunications Union (ITU) has established universal standards for faxes and modems, including intergenerational compatibility. Prior to these standards, rival incompatible fax protocols failed to gain popularity. The telephone network and the Internet require a myriad of standards to function properly.

The need for standards creates an imperative for various firms to work together to develop, establish, endorse, and promote those standards. Sometimes these alliances are strictly among companies selling complementary components that work together to form a system, as when Intel and Microsoft team up to make sure that their chips and operating system function smoothly in concert. More often, however, companies that compete directly with one another agree on compatibility or interface standards to build sufficient support for a new technology, as when Sony and Philips jointly established and licensed the CD standard, and when modem manufacturers around the world agree on a new modem standard at the ITU. Such cooperation naturally raises the spectre of antitrust sanctions: where does legitimate cooperation end and collusion begin? That is the topic of this chapter.[2]

[1] See Achsah Nesmith, *A Long, Arduous March Towards Standardization*, SMITHSONIAN, 176 (March 1985), for an entertaining description of standard setting through the ages.

[2] For other discussions of the issues discussed herein, see David Balto, *Networks and Exclusivity: Antitrust Analysis to Promote Network Competition*, 7 GEORGE MASON LAW REVIEW 523–76 (1999); Nicholas Economides & Lawrence J. White, *Networks and Compatibility: Implications for Antitrust*, *in* 38 EUROPEAN ECON. REV. 651 (1994); Joseph Farrell & Michael Katz, *The Effects of Antitrust and Intellectual Property Law on Compatibility and Innovation*, ANTITRUST BULL. (1998); Joseph Farrell & Garth Saloner, *Standardization, Compatibility, and Innovation*, 16 RAND J. ECON. 70 (1985); Joseph, Farrell and Garth Saloner, *Installed Base and Compatibility: Innovation, Product Preannouncement, and Predation*, 76 AM. ECON. REV. 940 (1986); Federal Trade Commission, *Competition Policy in the New High-Tech Global Marketplace*, STAFF REPORT (1996); Richard Gilbert & Carl Shapiro, *Antitrust Issues in the Licensing of Intellectual Property: The Nine No-No's Meet the Nineties*, BROOKINGS PAPERS ON ECONOMICS: MICROECONOMICS (1998); Michael Katz & Carl Shapiro, *Network Externalities, Competition and Compatibility*, 75 AMER. ECON. REV. 424 (1985); Michael Katz & Carl Shapiro, *Technology Adoption in the Presence of Network Externalities*, 94 JOURNAL OF POLITICAL ECONOMY 822 (1986); Michael Katz & Carl Shapiro, *Product Compatibility Choice in a Market with Technological Progress*, 38 OXFORD ECON. PAPERS 146 (1986); Michael Katz & Carl Shapiro, *Product Introduction with Network Externalities*, 40 (1) J. INDUS. ECON. 55 (1992); Michael Katz & Carl Shapiro, *Systems Competition and Network Effects*, 8 (2) J. ECON. PERSPECTIVES 93 (1994); Joel I. Klein, *Cross-Licensing and Antitrust Law* www.usdoj.gov/atr/speeches (1997); Joel I. Klein, *The Importance of Antitrust Enforcement in the New Economy*, www.usdoj.gov/atr/speeches (1998); Mark Lemley & David McGowan, *Legal Implications of Network Economic Effects*, 86 CALIF. L. REV. 479 (1998); Samuel R. Miller, *Antitrust and Competitor Collaboration in the Computer Industry*, FED. TRADE COMM'N, HEARINGS ON THE CHANGING NATURE OF COMPETITION IN A GLOBAL AND INNOVATION-DRIVEN AGE (Oct. 26, 1995); Jeffrey Rohlfs, *A Theory of Interdependent Demand for a Communications Service*, 5 (1) BELL J. ECON.16 (1974); Carl Shapiro, *Antitrust in Network Industries*, www.usdoj.gov/atr/speeches (1996); U.S. Dept. of Justice & Fed. Trade Comm'n, *Antitrust Guidelines for the Licensing of Intellectual Property*, April 1995, http://www.usdoj.gov/atr/public/guidelines/ipguide.htm; U.S. Dept. Justice & Fed. Trade Comm'n, *Antitrust Guidelines for Collaborations Among Competitors*, April 2000, http://www.ftc.gov/os/2000/04/ftcdojguidelines.pdf.

I. Standard Setting in Practice

A. Some examples of standards

Standards are not new, but they are growing in importance. Why? Because standards are especially important in the sector of the economy that is growing most rapidly, the sector encompassing information, communications, and entertainment, or ICE. Information systems require standards for the storage, retrieval, and manipulation of information, be it a corporate database, a spreadsheet, an inventory management system, or a library of images. Whether the message is voice, data, or a video signal, communications cannot take place without standards linking the parties sending and receiving the messages. And entertainment systems are built on standards, such as the CD standard for music or the new standard for digital television.

Before launching into the economics and the law surrounding standards, it is useful to simply list some examples of standards, both de facto and de jure standards. Most of the standards listed are successful ones, but not all. Others are still struggling for supremacy. Most of these examples illustrate the need for cooperation to establish successfully new standards. The examples also are suggestive regarding the impact of standards on competition.

In the area of consumer electronics: the old 33⅓ rpm standard for LP records; the Sony/Philips standard for CD players and disks; the VHS standard for video cassette players; the Sony mini-disk and digital audio tape (DAT) standards; the Philips digital compact cassette technology; the emerging standard for digital video disks (DVD); the NTSC and PAL standards for television transmission and reception; and the new HDTV standard for digital television.

In the computer hardware realm: the earlier 5¼ inch floppy disk drive standard; the newer 3½ inch floppy disk drive standard; yet newer high-capacity drives such as the Zip drive by Iomega; the VGA video display standard; various buses that transport data from one component to another; and the Intel x86 microprocessor architecture.

In the computer software realm: the Microsoft Windows operating system; the MPEG standard for compressing video data; Adobe PostScript, a page description language; Adobe Acrobat, a standard for making documents 'portable'; and the *lack* of a single version of UNIX.

In the financial world: the standards required for consumers to be able to make purchases or obtain money at a large network of locations: the standards for ATM cards and networks; the standards for the acceptance and processing of credit cards; and the standards embodied in smart cards.

In the communications realm: a multitude of standards that permit the operation of an integrated worldwide telephone system; the fax and modem standards noted above; a welter of Internet protocols; the Ethernet standard for local data networks; the GSM standard for wireless telephone systems; and many, many more.

B. Formal standard-setting bodies

Most standard setting takes place through formal standard-setting processes established by various standards bodies. Never before have such cooperative, political processes been so important to market competition. There are hundreds of official standard-setting bodies throughout the world. Some, like the Underwriter's Laboratory, which sets safety standards, are household words. Others, like the International Telecommunications Union (ITU) seem far removed from everyday experience but exert significant, behind-the-scenes influence. Some are independent professional organizations, like the Institute of Electric and Electronic Engineers (IEEE); others are government bodies, like the National Institute of Standards and Technology (NIST).

And these are only the *official* standard-setting bodies. On top of these, we have any number of unofficial groups haggling over product specifications, as well as various Special Interest Groups (SIGs) that offer forums for the exchange of information about product specifications. For example, there are 36 SIGs operating under the auspices of the Association for Computing Machinery (ACM) alone, including SIGART (artificial intelligence), SIGCOMM (data communications), SIGGRAPH (computer graphics), and SIGIR (information retrieval).

Participants often complain about the formal standard-setting process: it is slow, it is too political, it doesn't pick the 'best' technology, and so on. But history proves that the consensus process of formal standard-setting is time and again critical to launching new technologies. The telecommunications industry, for example, has relied on the ITU to set international standards, starting with the telegraph in the 1860s, through radio in the 1920s, to a panoply of standards today, from the assignment of telephone numbers, to protection against interference, to data protocols for multimedia conferencing. Whether you consider formal standard-setting a necessary evil or a godsend, it is here to stay.

Formal standard setting is designed to be open to all participants and to foster consensus. This sounds good, but often results in a very slow process. The HDTV story is one example: it took roughly 10 years to set a technical standard for digital television in the United States, and HDTV is yet to be adopted in the United States on a commercial scale.

A fundamental principle underlying the consensus approach to standards is that they should be 'open', with no one or few firms controlling the standard. Thus, a quid pro quo for the inclusion of a participant's technology in a formal standard is a commitment by that participant to license any of its patents *essential* to implementing the standard on 'fair, reasonable, and non-discriminatory' (FRND) terms. Note that this duty does *not* extend to *non-essential* patents, which can lead to an amusing dance in which companies claim that their patents merely cover valuable enhancements to the standard and are not actually essential to complying with the standard.

The openness promise of a formal standards body is a powerful tool for establishing credibility. However, be aware that most standards bodies have no enforcement authority. Aggrieved parties must resort to the courts, including the court of public opinion, if they feel the process has been abused. In the United States at least, the result has been a variety of private lawsuits involving patent misuse and/or antitrust claims.

The granddaddy of organizations setting standards for information infrastructure is the International Telecommunications Union (ITU).[3] The ITU grew out of the International Telegraph Convention of 1865, signed by 20 European countries to coordinate use of the telegraph. It became an agency within the United Nations in 1947. The key part of the ITU for telecommunications standards is the International Telephone and Telegraph Consultative Committee (CCITT).

The ITU is notoriously slow, in part because there are so many member countries, and in part because companies in each country must first work to reach a national consensus which is then communicated to the ITU. For example, for some ITU Recommendations, the Telecommunications Industry Association (TIA) communicates the interests of American companies to the State Department, which then formally represents the United States at the ITU. The ITU's strong tradition and insistence on an open consensual process also slows things down. Some observers have suggested that the ITU will have to speed up or cede power to regional standards organizations keen on swifter adoption of new technologies.

The fact remains, however, that the ITU plays a crucial role in setting standards that truly require a worldwide consensus, such as standards for fax

[3] See http://www.itu.ch.

machines, modems, the public switched telephone system, and the use of spectrum. The ITU also has clear rules requiring companies to license any patents essential to a standard. Oddly, however, the ITU steadfastly refuses to broker agreements among companies with rival or complementary patent portfolios. Those deals have to be cut in a sidebar, not formally under ITU auspices.

Within the United States, the American National Standards Institute (ANSI)[4] is the umbrella organization most widely responsible for promoting formal standard setting. ANSI's aim is to promote and facilitate voluntary consensus standards. ANSI does not itself promulgate standards, but rather helps establish consensus among qualified groups. ANSI's guiding principles are consensus, due process, and openness. Some 175 distinct entities are currently accredited by ANSI and some 11,500 American National Standards have been approved under ANSI oversight. ANSI has established an Information Infrastructure Standards Panel to facilitate development of standards critical to the Global Information Infrastructure. ANSI also has helped establish, with some government financing through the National Institute of Standards and Technology (NIST), the NSSN, a Web-based information resource on standards, including a database pointing to over 100,000 standards currently in use.[5]

ANSI is the US representative of the two major non-treaty international standards organizations, the International Organization for Standardization (ISO)[6] and the International Electrotechnical Commission (IEC).[7] The ISO is a worldwide federation of national standards bodies, one from each of about 100 countries, dating back to 1947. The ISO seeks voluntary, industry-wide, global consensus—no small feat! ISO standards cover everything from film speeds to standardized freight containers, to safety, to symbols for automobile dashboard controls. The ISO covers all areas except electrical and electronic engineering, which is the responsibility of IEC. The ISO and the IEC handle the field of information technology together through a joint technical committee, JTC1.

Finally, it is important to bear in mind that a great deal of standard setting takes place through less formal cooperative arrangements among firms. Indeed, a day hardly goes by without some announcement of an alliance, joint venture, or other agreement that high-tech firms have entered into to adopt and promote certain would-be standards. A company like RealNetworks, which develops multimedia software, is continually lining up support for its RealPlayer audio player and associated formats.[8] In these less formal cases of standard setting, which may involve standards wars, firms that have not been invited to participate in the establishment of standards (or who are denied

[4] See http://www.ansi.org.
[5] See http://www.nssn.org.
[6] See http://www.iso.ch.
[7] See http://www.iec.ch.
[8] See www.realnetworks.com.

compatibility with the standard) may complain at their exclusion, and all manner of licensing and cross-licensing arrangements can be found.

II. The Impact of Cooperative Standard Setting

As illustrated by the examples listed above, antitrust concerns have clearly not prevented many cooperative standard-setting efforts from proceeding forward. Indeed, even the fiercest enemies often team up in the software industry to promote new standards. For example, in 1997 Microsoft and Netscape, two companies hardly known as cozy partners, agreed to include compatible versions of Virtual Reality Modeling Language (developed by Silicon Graphics) in their browsers. This agreement was expected to make it easier for consumers to view 3-D images on the Web. Earlier, Microsoft agreed to support the Open Profiling Standard, which permits users of personal computers to control what personal information is disclosed to a particular website, and which had previously been advanced by Netscape, along with Firefly Network, Inc. and Verisign Inc.

But neither is cooperative standard setting immune from antitrust scrutiny. In the consumer electronics area, for example, the Justice Department investigated Sony, Philips, and others regarding the establishment of the CD standard in the 1980s. Cooperative efforts to set optical disc standards have also been challenged in private antitrust cases, on the theory that agreements to adhere to a standard are an unreasonable restraint of trade:

> [d]efendants have agreed, combined, and conspired to eliminate competition . . . by agreeing not to compete in the design of formats for compact discs and compact disc players, and by instead agreeing to establish, and establishing, a common format and design . . .[9]

Does cooperation lead to efficient standardization, increased competition, and additional consumer benefits? Or is cooperative standard setting a means for firms collectively to stifle competition, to the detriment of consumers and firms not included in the standard-setting group? Answering these questions and evaluating the limits that should be placed on cooperative standard-setting efforts requires an analysis of the competitive effects of such cooperation in comparison with some reasonable but-for world. Inevitably, an antitrust analysis of cooperative standard setting involves an assessment of how the market would likely evolve *without* the cooperation. One possibility is that multiple, incompatible products would prevail in the market, if not for the cooperation. Another possibility is that the market would eventually tip to a single product, even without cooperation. Even in this latter case, an

[9] 'Second Amended Complaint', *Disctronics Texas, Inc., et al. v. Pioneer Electronic Corp. et al.*, Eastern District of Texas, Case No. 4:95 CV 229, filed August 2, 1996, at 12.

initial industry-wide standard can have significant efficiency and welfare consequences, for three reasons: (1) cooperation may lock in a different product design than would emerge from competition; (2) cooperation may eliminate a standards war waged prior to tipping; and (3) cooperation is likely to enable multiple firms to supply the industry-standard product, whereas a standards war may lead to a single, proprietary product.

A. The costs and benefits of compatibility and standards

I begin by laying out the costs and benefits of achieving compatibility. I then turn to the legal treatment of cooperation to set compatibility standards.

1. Greater realization of network effects

When all users are on a single network, the size of the network is maximized and so is the realization of network benefits. For communication networks, users benefit from the fact that any given user can communicate with any other. For hardware-software networks, users benefit from the fact that firms supplying components have access to a large market for their software. This is likely to lead to increased entry and variety, and greater price and innovation competition in the supply of individual components.

2. Buyers are protected from stranding

When products are compatible, a consumer does not fear being stranded when he or she chooses to make a purchase from a particular supplier. When a consumer buys a television set in the United States, for example, he or she knows that it is compatible with the signals sent out by local broadcasters—the Federal Communications Commission (FCC) sets standards that all television receivers must meet. In contrast, neither the FCC nor anyone else set AM stereo standards for years. The result was consumer confusion and a reluctance to buy. Incompatibility between the Sony mini-disc and the Philips digital compact cassette led to a similar result.

3. Constraints on variety and innovation

The need to adhere to a standard imposes limits on firms' product design choices. Unlike the first two effects of standardization, this effect is a cost. Limits on design choices can lead to static losses from the reduction in variety. And they can lead to dynamic losses as firms are foreclosed from certain paths of R&D that could result in innovative new products that could not comply with the standards. Note that these limits impose costs both at the time a new product is created, and later when it is possible to introduce a new generation offering greatly enhanced performance. In the latter case, firms must confront the issue of whether to preserve intergenerational compatibility.

4. Impact on competition

In the presence of network effects, compatibility can fundamentally affect the nature of competition. The importance of compatibility stems from the fact that compatible products constitute a single network. Increased adoption of one vendor's product does not create a competitive advantage for that vendor relative to its rivals because the rivals' products also benefit from the larger network size. In contrast, when products are incompatible, different brands constitute different networks. Consequently, the increased adoption of one brand creates a larger network for that product but not for competing products. Thus, increased adoption of a particular product creates an ongoing competitive advantage for that product by raising the value of that brand relative to brands that are not part of that network.

This fact has several consequences. To illustrate, suppose that everyone expects the market to tip eventually. If these expectations are correct, then eventually there will be a single network, whether or not firms agree to common standard. In this setting, there are two ways to achieve industry-wide compatibility. One is for firms to agree up front to a common standard. The other is for firms to battle for dominance. Under incompatibility, firms will *compete for the market*. Firms may make big investments and incur initial losses as the attempt to become the dominant network. In contrast, under compatibility, firms will *compete within the market*. Network effects do not provide a means for a firm to pull ahead of its rivals and perhaps even become a monopolist. Instead, firms will compete along other dimensions, such as price, product features, and post-sales service.

This suggests an overall pattern. Cooperative standard setting mutes the intense front-end competition characteristic of a standards war, while permitting greater competition later in the life of a product, since multiple firms can provide products that comply with the standard. In other words, cooperative standard setting tends to decrease competition along some dimensions, and in the near term, while increasing competition on other dimensions and in the future. On net, compatibility can either increase or decrease competition, depending on market conditions. To see how standardization affects competition, we must compare the evolution of a market with and without the compatibility of competing products.

One must be careful in applying this analysis of competitive effects. Generally, it does not give a clear answer, but rather suggests a tradeoff: ex ante versus ex post competition, you can have one but not both. There is, however, an important set of situations in which compatibility gives rise to increased competition at all points in time. These situations arise when the entire product category would fail to take off in the absence of standardization. This can happen if consumers withhold making initial purchases (or if producers of complementary components refrain from making investments) because they are too worried about being locked in to the wrong choice.

5. *Weighing the benefits and costs*

This discussion should make it clear that there are no easy or general answers regarding the impact of cooperative standard setting on competition, efficiency, and consumer welfare. Still, I believe that this economic framework helps frame the key questions and gives insight into the proper scope for collective standard setting. As a general matter, antitrust analysis of interfirm cooperation should assess the harm to third parties who are not part of the agreement. The leading candidates are consumers, those offering complements, and suppliers of the product who do not control and/or participate in the standard-setting process.

The clearest case favoring standard setting arises when collective action is essential to get the bandwagon moving at all. This could happen if two or more firms have crucial intellectual property that must be contributed to develop a successful product; see the section below on cross-licensing and patent pools. This also could happen if consumers simply would not adopt any product without the unified support of a number of suppliers. In these situations, collective standard setting benefits consumers as well as the vendors.

Collective standard setting also is likely to be desirable, even if multiple suppliers could offer competing products, so long as network effects are strong and the standard does not unnecessarily restrict product variety. Because of the network effects, total efficiency is greatest when there is a single network; the best one can hope for is to achieve this result while enabling several firms to offer compatible programs. If variety can still flourish within the standard, the outcome can be very efficient and preserve considerable competition even while exploiting network effects.

Cooperation becomes more problematic if the participants agree to standards that compel each to pay royalties to the others. This may simply be a form of induced collusion. One sign of this may be agreements where one piece of intellectual property from each member of the coalition is included in the standard. Of course, this pattern may also reflect the fact that the parties are getting together to resolve blocking intellectual property rights, in which case cooperation is necessary to move forward at all. To distinguish the cartel situation from the patent unblocking situation, the key question is whether a successful product could be launched by one or a subset of the parties without infringing the intellectual property rights of the others.

Another pattern worthy of antitrust attention arises when a subset of firms in an industry adopt a standard that encompasses their intellectual property rights and makes it necessary for anyone producing to that standard to make payments to those firms. This can be a means for that set of firms jointly to monopolize the market. Such concerns can be alleviated if the firms agree to license their intellectual property openly on fair and reasonable terms, as required by numerous standard-setting organizations including the American National Standards Institute and the International Standards Organization.

B. Legal treatment of cooperative standard setting

The question of whether firms should be allowed, or even encouraged, to set standards cooperatively is part of the broader issue of collaboration among competitors, a storied area within antitrust law. Most of the case law deals with *quality and performance standards* rather than *compatibility standards*.[10] Existing cases have also tended to focus on the standard-setting *process* itself, rather than the outcomes of cooperative standard setting.

Antitrust liability has been found for participants in a standard-setting process who abuse that process to exclude competitors from the market. One leading case is *Allied Tube & Conduit Corp. v. Indian Head, Inc*,[11] in which the Supreme Court affirmed a jury verdict against a group of manufacturers of steel conduit for electrical cable. These manufacturers conspired to block an amendment of the National Electric Code that would have permitted the use of plastic conduit. They achieved this by 'packing' the annual meeting of the National Fire Protection Association, whose model code is widely adopted by state and local governments.[12] The other leading case is *American Society of Mechanical Engineers v. Hydrolevel Corp*,[13] in which the Supreme Court affirmed an antitrust judgment against a trade association. In this case, the chairman of an association subcommittee offered an 'unofficial' ruling that plaintiff's product was unsafe, and this ruling was used by plaintiff's rival (who enjoyed representation on the subcommittee) to discourage customers from buying plaintiff's product.

Antitrust risks associated with excluding a rival from the market appear to be less of a problem for an 'open' standard, but could arise if the companies promoting the standard block others from adhering to the standard or seek royalties from outsiders.

As the Supreme Court has noted, '[a]greement on a product standard is, after all, implicitly an agreement not to manufacture, distribute, or purchase certain types of products'.[14] To date, this type of reasoning has not been used to impose per se liability on standard-setting activities. Indeed, I know of no successful antitrust challenges to cooperation to set compatibility standards. The closest case of which I am aware is *Addamax Corporation v. Open*

[10] See James Anton & Dennis Yao, *Standard-Setting Consortia, Antitrust, and High-Technology Industries*, 64 ANTITRUST L. J. 247 (1995), for a more complete discussion of the legal treatment of performance standards.

[11] 486 U.S. 492 (1988).

[12] As described in Samuel R. Miller, HIJACKING THE STANDARD-SETTING PROCESS—THE ANTITRUST RISKS 5 (Folger & Levin Firm, San Francisco, CA, May 1996): 'The defendants recruited 230 people to join the standard-setting association and attend the meeting at a cost of more than $100,000. The steel group voters were instructed where to sit and how and when to vote by group leaders who used walkie-talkies and hand signals to facilitate communication' (*citing Allied Tube & Conduit Corp*, 486 U.S. at 496–97).

[13] 456 U.S. 556 (1982).

[14] *Allied Tube & Conduct Corp.*, n. 11 above, 486 U.S. at 500.

Software Foundation, Inc.[15] In *Addamax*, the District Court refused to grant summary judgment on behalf of the Open Software Foundation, an industry consortium formed to develop a platform-independent version of the UNIX operating system. OSF conducted a bidding to select a supplier of security software. After failing to be selected, Addamax brought antitrust claims against OSF, Hewlett Packard, and Digital Equipment Corporation, asserting that OSF had chosen the winner not based on the merits but to favor specific companies and technologies. The *Addamax* case looks problematic (although, admittedly, the court was only permitting a rule-of-reason claim to go forward), inasmuch as the primary purpose of OSF was to permit its members to team up to offer stronger competition against the leading UNIX vendors, Sun Microsystems and AT&T, and there was no evidence suggesting that OSF's failure to pick Addamax was based on its members' desire to control the market in which Addamax itself operated.

I believe that the antitrust risks faced by companies that are trying to set compatibility standards are minor as long as the scope of the agreement is limited to standard setting. While the law has typically looked for integration and risk sharing among collaborators in order to classify cooperation as a joint venture and escape per se condemnation, these are not very helpful or useful screens for standard-setting activities. The essence of cooperative standard setting is not the sharing of risks associated with specific investments, or the integration of operations, but rather the contribution of complementary intellectual property rights and the expression of unified support to ignite positive feedback for a new technology.

C. Policy implications

What does this analysis tell us that antitrust enforcers should look for when deciding whether to allow cooperative standard setting?

- *Do the firms in the proposed standards coalition have market power?* Answering this question is made difficult by the fact that the product may not yet have been brought to market. The analysis must thus focus on capabilities. In this sense, the inquiry is akin to conducting a market power analysis for a merger case based on potential entry effects. If the firms collectively lack market power and there are firms that jointly or individually could put forth competing standards, then the cooperation is unlikely to harm competition.
- *Does the coalition have open or closed membership?* Open membership defuses the danger that the firms involved will exclude others from the market, but increases the likelihood that the members collectively do or will possess market power. 'Small' open groups thus are the least worrisome. 'Large' open groups can also be highly pro-competitive, especially if the members are not restricted in their ability to compete independently of each other and even outside of the standard.
- *Do members of the coalition possess blocking patents or other intellectual property rights?* If two or more companies each have patents that are essential to production of goods, then some form of cooperation is far more likely to be desirable. Cooperation is not essential; the firms might be able to license each other and third parties separately. However, separate licensing is prone to higher royalty rates than collective licensing because an owner of intellectual property rights acting individually fails to take into account the harm it does to holders of complementary intellectual property rights when it raises its license fees. (See the Technical Appendix below.)
- *Are royalties required to adhere to the standard?* Such royalties will tend to raise the price of any product complying with the standard. Royalties that reward owners of blocking patents or copyrights are easily defensible, but royalties can have cartel-like effects.
- *Is coordination critical to the launch of the product?* Cooperation is desirable in those situations where the product would fail to take off in the absence of standardization. Of course, the difficulty in applying this standard is to determine whether standardization really is needed. Indications that either buyers or the suppliers of complementary components strongly favored standards can provide very valuable evidence.
- *What ancillary restraints are placed on members of the standards coalition?* Is a member firm allowed to produce products that do not adhere to the standard? If there are no limitations, then cooperation is less likely to harm competition. It is important to recognize, however, that there may be good reasons to limit members' ability to produce non-standard products.

[15] 888 F. Supp. 274 (D.Ma. 1995). The court subsequently held that even assuming an antitrust violation, Addamax would not have been entitled to damages, see 964 F.Supp.549 (D.Ma. 1997), *aff'd*, 152 F. 3d 48 (1st Cir. 1998).

III. Standard Setting and Intellectual Property Rights

I now look more closely at two intellectual property issues that frequently arise in the context of standard setting: the use of cross-licenses and/or patent pools; and the duties of participants to license their patents on 'reasonable' terms.

A. Cross-licenses and patent pools

All too often in high-tech markets, several firms control property rights that must be combined to bring products to market. In other words, blocking patents are not unusual. This is especially true in a standard-setting context:

if multiple firms own patents that are essential to comply with the product standard, they each can block all others from making compatible products. For precisely this reason, standard-setting bodies require participants to license any essential patents on reasonable terms.

The case in which multiple firms control patents essential to a standard is amenable to formal economic analysis. In essence, any manufacturer seeking to produce a compliant product must obtain a license from each rights holder to avoid facing an infringement action. This is a classic case in which the manufacturer requires each of several inputs in fixed proportion. The Technical Appendix below sketches out the most basic theory of the pricing of such complementary inputs. As shown there, prices are higher if these patents are controlled and licensed separately than if they are under consolidated control. (The Appendix only covers the case of two essential patents, but the theory extends naturally and easily to multiple essential patents. The greater the number of such patents, the more important it is to coordinate their pricing to avoid stifling product demand.)

The basic theory of complements shown in the Technical Appendix gives strong support for competition authorities to welcome either cross-licenses or patent pools to clear such blocking positions. If the two patent holders are the only companies capable of manufacturing compliant products, a royalty-free cross-license is ideal from the point of view of (ex post) competition, but *any* cross-license is superior to a world in which the patent holders fail to cooperate, since neither could proceed in that world without infringing on the other's patents. Alternatively, if the patent holders see benefits from enabling many others to make compliant products, a patent pool, under which all the blocking patents are licensed in a coordinated fashion, can be an ideal outcome. The simple theory in the Technical Appendix suggests that coordinating such licensing can lead to *lower* royalty rates than would independent pricing of the patents. Of course, the best outcome of all may be for other manufacturers and perhaps large users to insist on low or nominal royalties as a quid pro quo for supporting the standard in the first place.

An excellent illustration of how the enforcement agencies can successfully handle intellectual property in the standard-setting context comes from the Justice Department's June 1997 approval of the proposal by Columbia University and nine companies to create a clearinghouse to offer a package license of patents needed to meet the MPEG-2 video compression standard developed by the Motion Picture Expert Group. The portfolio will only contain patents found to be truly essential to the MPEG-2 standard. The MPEG-2 standard is used in many forms of digital transmissions, including digital television, direct broadcast satellite, digital cable systems, personal computer video, DVD, and interactive media. It was important to the Justice Department that the pool was restricted to blocking patents, which are complements, not substitutes, as determined by an independent expert. The scope

of the cooperation endorsed by the Justice Department was to unblock patent positions, and to reduce transactions costs through the use of a clearinghouse. Similar reasoning was applied by the Justice Department in two business review letters involving Digital Versatile Disk (DVD) standards.[16]

Another interesting case involving a patent pool is the March 1998 Federal Trade Commission complaint against Summit Technology, Inc. and VISX, Inc. two firms that market lasers to perform a new, and increasingly popular, vision correcting eye surgery, photorefractive keratectomy. According to the FTC: 'Instead of competing with each other, the firms placed their competing patents in a patent pool and share the proceeds each and every time a Summit or VISX laser is used'. A key issue for analysis is whether the companies indeed held *competing* patents or alternatively *blocking* patents, and just what the standard will be for defining 'blocking' patents.[17]

B. Hidden intellectual property rights

Firms are sometimes accused of hiding intellectual property rights until after the proprietary technology has been embedded in a formal standard. I view this issue primarily as one of contract law. Standard-setting groups should—and often do—have provisions in their charters compelling members either to reveal all relevant patents (thus giving others fair notice and the opportunity to design around those patents) or to commit to licensing any patents embedded in the standard on 'reasonable' terms.

In some cases, however, the precise requirements imposed by a standard-setting group may be unclear. In these circumstances, if the standard affects non-participants, including consumers, there is a public interest in clarifying the duties imposed on participants in a fashion that promotes rather than stifles competition.

1. Dell Computer and the VESA VL-bus standard

One leading US example of this type of antitrust action is FTC's consent agreement with Dell Computer Corporation, announced in November 1995. Although the case involved computer hardware, it is important for a wide

[16] First, in December 1998 (see http://www.usdoj.gov/atr/public/press_releases/1998/2120.htm), the Department approved a proposal by Philips, Sony, and Pioneer jointly to license patents necessary to make discs and players that comply with the DVD-Video and DVD-ROM standards. Secondly, in June 1999 (see http://www.usdoj.gov/atr/public/press_releases/1999/2484.htm), the Department approved a joint licensing scheme relating to the DVD-Video and DVD-ROM standards; this second arrangement includes patents held by Toshiba (the licensing entity), Hitachi, Matsushita, Mitsubishi, Time Warner, and Victor Company of Japan.

[17] The companies subsequently dissolved their pooling venture, agreed not to fix prices for their lasers and patents, and agreed to cross-license their patents on a royalty-free basis. See *In Re Summit Technology*, 1999 FTC Lexis 23 (Feb. 23, 1999).

range of standard-setting activities. The assertion was that Dell threatened to exercise undisclosed patent rights against computer companies adopting the VL-bus standard, a mechanism to transfer data instructions between the computer's CPU and its peripherals such as the hard disk drive or the display screen. The VL-bus was used in 486 chips, but it has now been supplanted by the PCI bus. According to the FTC:

> During the standard-setting process, VESA [Video Electronics Standard Association] asked its members to certify whether they had any patents, trademarks, or copyrights that conflicted with the proposed VL-bus standard; Dell certified that it had no such intellectual property rights. After VESA adopted the standard—based in part, on Dell's certification—Dell sought to enforce its patent against firms planning to follow the standard.[18]

There were two controversial issues surrounding this consent decree: (a) the FTC did not assert that Dell acquired market power, and indeed the VL-bus never was successful; and (b) the FTC did not assert that Dell *intentionally* misled VESA. My analysis suggests that anticompetitive harm is unlikely to arise in the absence of significant market power and that the competitive effects are not dependent on Dell's intentions.

2. Motorola and the ITU V.34 modem standard

Another good example of how competition can be affected when standard-setting organizations impose ambiguous duties on participants is the case of Motorola and the V.34 modem standard adopted by the International Telecommunications Union. Motorola agreed to license its patents essential to the modem standard to all comers on 'fair, reasonable, and non-discriminatory terms'.[19] Once the standard was in place, Motorola then made offers that some industry participants did not regard as meeting this obligation. Litigation ensued between Rockwell and Motorola, in part over the question of whether 'reasonable' terms should mean: (a) the terms that Motorola could have obtained ex ante, in competition with other technology that could have been placed in the standard; or (b) the terms that Motorola could extract ex post, given that the standard is set and Motorola's patents are essential to that standard.

These issues are best dealt with by the standard-setting bodies, or standard-setting participants, either by making more explicit the duties imposed on participants, or by encouraging ex ante competition among different holders of intellectual property rights to get their property into the standard. Unfortunately, antitrust concerns have led at least some of these bodies to

[18] See http://www.ftc.gov/opa/9606/dell2.htm. Another important case involving the disclosure of patent applications in the standard-setting process is *Wang Lab. v. Mitsubishi Elec. Amer.*, No. CV92-4698 JGD (C.D. Cal. 1993).

[19] I served as an expert in this matter retained by Rockwell; the views stated here do not necessarily reflect those of any party to the case.

steer clear of such ex ante competition, on the grounds that their job is merely to set technical standards, not to get involved in 'prices', including the terms on which intellectual property will be made available to other participants. The ironic result has been to embolden some companies to seek substantial royalties after participating in formal standard-setting activities.

IV. Conclusion

Standard setting is here to stay, with a vengeance. As more and more products work in conjunction to form systems, interface standards play a bigger and bigger role in the economy. And, as computer and communications systems encompass a larger portion of economic activity, compatibility standards become an ever-more important aspect of competitive strategy. Intellectual property law and antitrust law must adapt to keep pace with these changes.

Clearly, there is an enormous amount of cooperative standard setting, little of which is impeded by antitrust concerns. At the same time, some very thorny issues arise when firms control intellectual property essential to a standard: what is the duty to disclose the existence of such rights, how do we interpret duties to license such property on 'fair, reasonable and non-discriminatory' terms, and how are competition authorities to treat cross-license and patent pools that arise in the context of new product standards? Generally, patent holders should be given wide latitude to fashion arrangements to cooperate to clear blocking patents.

Technical Appendix: Pricing of Components and Systems

1. The model

Consider a situation in which two components, A and B, are used in fixed proportions to constitute a system. Let the unit cost of components A and B be c_A and c_B respectively. Call the unit cost of a system $c_S \equiv c_A + c_B$. By making c_A and c_B invariant with respect to the institutional setting (see below), we are assuming that there are no economies or diseconomies of scope if the system is assembled within one firm vs. two. The focus here is thus entirely on pricing incentives for a given cost structure. The results here are well-known in the fields of microeconomics and industrial organization, but their implications for antitrust may not be fully appreciated. The treatment here is intended to illustrate some standard theoretical results, not to break new ground.

There are many examples of (actual or nearly) fixed-proportion components in the information sector, including (a) a computer and a monitor, (b) a computer and an operating system, or (c) a microprocessor and a chipset within the computer. We explore here the pricing of the components, and the system, in three different institutional settings.

The first setting is that of an *integrated firm* that manufacturers and assembles the entire system. Call the unit cost of the system $c_S = c_A + c_B$. Call the price of the system to consumers, to be set by the seller, p_S.

The second setting is a *vertical chain* in which firm *A* manufacturers and sells component *A* to firm *B*, which then combines the *A* component with the *B* component and sells the resulting system to consumers. Firm *B* sets the system price p_S. In this case, call p_A the price for component *A* that firm *A* charges to firm *B*.

The third setting involves the *complements*: each of the two firms, *A* and *B*, sells its component to the consumer, which then combines the components into a system. In this case, call the prices charged by the two firms p_A and p_B; the system price faced by the consumer is $p_A + p_B$.

Consumers ultimately care about the total price of the system, p_S, which governs the demand for systems. Call this demand relationship $x_S = D(p_S)$, where x_S is unit sales of systems, and the demand function, $D(\cdot)$ is downward sloping, exhibits declining marginal revenue, and satisfies the usual regularity conditions for oligopoly theory. We will illustrate our results using the constant-elasticity demand curve, $D(p_S) = P_S^{-\epsilon}$. Note for use below that in this special case

$$-\frac{D(p_s)}{D'(p_s)} = pS/\epsilon.$$

Note also that in general $-D(p_S)/D'(p_S)$ is equal to the difference between price and marginal revenue at the price p_S, or, equivalently, at output level $D(p_S)$.

2. *Integrated firm*

With a single, integrated, firm, we have a standard monopoly pricing problem. The firm's problem is to pick p_S to maximize

$$D(p_S)(p_S - c_S)$$

The standard solution can be written as

$$p_s - c_s = -\frac{D(p_s)}{D'(p_s)}$$

With constant-elasticity demand, this gives the standard markup rule

$$p_s = \frac{c_s}{1 - 1/\epsilon}$$

3. *Vertical chain*

If firm *A* sets a single, uniform price p_A selling to firm *B*, which in turn sets a single uniform price selling to consumers, we have the standard 'chain of monopolies' problem. A standard result is that prices are higher under this structure than with an integrated monopolist.

The resulting price is obtained in two steps. First, consider how firm *B* prices the system for a given price p_A set by firm *A*. Effectively, firm *B* now has a unit cost of each system of $p_A + c_B$. Naturally, this leads to a higher system price to consumers than would unit costs of $c_A + c_B$, as in the integrated case just above. Firm *B* thus prices according to the rule

$$p_S - (p_A + c_B) = -\frac{D(p_S)}{D'(p_S)}$$

With constant-elasticity demand, substituting for $-D/D'$ gives

$$p_s\left(1 - \frac{1}{\epsilon}\right) = p_A + c_B$$

The next step is to determine *A*'s optimal pricing, given *B*'s demand as reflected in the equation just above. This is analogous to the Stackelberg problem in standard oligopoly theory. Firm *A* sets p_A to maximize $D(p_S)(p_A - c_A)$, where p_S is determined by the relationship just above. In the case of constant elasticity of demand, using the linear relationship between p_S and p_A noted above, a series of calculations leads to the following expression for the resulting systems price:

$$p_s = \frac{c_s}{(1 - 1/\epsilon)^2}$$

4. *Complements*

If firms *A* and *B* each set prices independently for their components, the problem is analogous to Cournot oligopoly, as opposed to the Stackelberg solution just derived. Firm *A* sets p_A to maximize

$$D(p_A + p_B)(p_A - c_A)$$

taking p_B as given. Since $dp_S/dp_A = 1$ in this situation, the resulting first-order condition is simply

$$D(p_S) + D'(p_S)(p_A - c_A) = 0$$

Firm *B* does likewise, giving the analogous condition for p_B of

$$D(p_S) + D'(p_S)(p_B - c_B) = 0$$

Adding up these two first-order conditions gives

$$2D(p_S) + D'(p_S)(p_S - c_S) = 0$$

which can be rewritten as

$$p_s = c_s - 2\frac{D(p_s)}{D'(p_s)}$$

Note that this equation is identical to the equation for the integrated firm, except for the factor of two on the right-hand side. In the special case of constant-elasticity demand, we have

$$p_s = \frac{c_s}{1-2/\epsilon}$$

Notice that this special case becomes internally inconsistent if the elasticity of demand is less than two. (Each firm will want to set arbitrarily high prices.)

5. Pricing comparisons

We know that in general the system price set by the integrated firm is lower than the price under the vertical chain or complements. The intuition behind this result is as follows. Lower prices for one component generate a positive external effect of the owner of the other component. These externalities are internalized through integration, leading to lower prices. However, this intuition alone does not tell us whether the prices are highest under complements or the vertical chain.

In the case of constant elasticity of demand, the resulting systems prices are

$$p_s^I = \frac{c_s}{1-1/\epsilon}$$

for the integrated firm,

$$p_s^V = \frac{c_s}{(1-1/\epsilon)^2}$$

for the vertical chain, and

$$p_s^C = \frac{c_s}{1-2/\epsilon^2}$$

for the independent pricing of complements. Direct comparison of these prices reveals that the system price is lowest for the integrated firm, somewhat higher for the vertical chain, and highest of all under the complements arrangement.

In the case of constant elasticity of demand, prices are lower under the vertical chain than under complements because the upstream firm, which we have denoted by firm *A*, recognizes that firm *B* will *raise* its own component price in response to *A*'s higher price. Put differently, the system price will go up by more than one unit, for every unit increase in p_A. Another way to say this is that firm *B*'s reaction curve (optimal p_B as a function of p_A) is upward sloping. (This follows from the fact that a monopolist facing constant elasticity of demand, firm *B*, more than passes through any increases in unit costs, p_A.) Recognizing this reaction, firm *A* sets a lower price under the vertical chain than under complements pricing. It follows that the systems price is lower, because firm *B* is setting its optimal component price given p_A under either the vertical chain or complements structure.

More generally, the comparison of system prices between the vertical chain and complements depends upon whether the reaction curve of firm *B* is upward or downward sloping. Put differently, prices are higher under complements if and only if cost increases are more than passed through to final consumers. Formally, this occurs if and only if $dp_S/dp_A > 1$ in the vertical chain setting. (We always have $dp_S/dp_A = 1$ in the complements setting.) Since in general the vertical chain systems price is given by

$$p_s + \frac{D(p_s)}{D'(p_s)} = p_A + c_s$$

the comparison hinges on the derivative of the left-hand side of this equation with respect to p_S. A few steps of calculus tell us that prices are higher in the complements case if and only if the ratio $D(p_S)/D'(p_S)$ is declining in p_S, which is equivalent to

$$D'(p_S)D'(p_S) < D(p_S)D''(p_S)$$

(For simplicity, I am assuming that these various conditions hold or fail uniformly at all points on the demand curve.) This condition is always met for constant elasticity of demand.

Note, however, that the condition just provided always *fails* for linear (or concave) demand. Under those conditions, prices are higher in the *vertical chain* setting.

We can illustrate these points by solving the linear case explicitly. Suppose that demand for systems is given by $D(p_S) = K - p_S$. For simplicity, and without (further) loss of generality, let c_A and c_B equal zero. The integrated firm maximizes $(K - p_S)p_S$, which involves a systems price of $K/2$. Under complements, firm *A* maximizes $(K - p_A - p_B)p_A$, which gives a reaction curve of $p_A = (K - p_B)/2$. Solving for the equilibrium prices gives $p_A = p_B = K/3$, for a systems price under complements of $2K/3$.

Finally, under the vertical chain arrangement, firm *B*'s response to p_A is $p_B = (K - p_A)/2$, so firm *A*, the first mover, maximizes $(K - p_A - (K - p_A)/2)p_A$. The solution to this is given by $p_A = K/2$, causing *B* to set a component price of $K/4$, with a resulting systems price of $3K/4$. In this case, the systems price responds *less* than one-for-one to increases in p_A, so firm *A* is led to set a higher price under the vertical chain than under complements. In the linear case, firm *A* charges $K/2$ for its component, rather than $K/3$, an increase of $K/6$. However, firm *B* lowers its component price in response from $K/3$ to $K/4$, a decrease of only $K/12$ (the slope of *B*'s reaction function is only 1/2). As a result, the final systems price rises from $2K/3$ under complements to $3K/4$ under the vertical chain, an increase of $K/12$.