FROM PATENT THICKETS TO PATENT NETWORKS: THE LEGAL INFRASTRUCTURE OF THE DIGITAL ECONOMY

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ABSTRACT: Scholarly and popular commentary often asserts that markets characterized by intensive patent issuance and enforcement suffer from "patent thickets" that suppress innovation. This assertion is difficult to reconcile with continuous robust levels of research and development (R&D) investment, coupled with declining prices, in technology markets that have operated under intensive patent issuance and enforcement for several decades. Using network visualization software, I show that information and communication technology (ICT) markets rely on patent pools and other cross-licensing structures to mitigate or avoid patent thickets and associated inefficiencies. Based on the composition, structure, terms, and pricing of selected leading patent pools in the ICT market, I argue that those pools are best understood as mechanisms by which vertically integrated firms mitigate transactional frictions and reduce the cost of accessing technology inputs. Appropriately structured patent pools can yield cost savings for intermediate users, which may translate into reduced prices for end users, but at the risk of undercompensating R&D suppliers.

CITATION: Jonathan M. Barnett, From Patent Thickets to Patent Networks: The Legal Infrastructure of the Digital Economy, 55 Jurimetrics J. 1–53 (2014).

Scholarly and popular commentary on the patent system often asserts that the U.S. patent system is in a state of overexpansion that has suppressed innovation in a morass of intellectual property rights, licensing negotiations, and

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infringement litigation. Headline coverage of patent disputes among some of the world's largest technology companies—Google, Apple, Samsung, Microsoft—buttresses that view. Despite this impression, there is little evidence showing that the burdens allegedly imposed by the patent system have resulted in a decline in research and development (R&D) investment or other measures of innovative health. This article provides a different picture of the U.S. patent system—one for which there *is* ample evidence. Leading participants in the global market for information and communications technologies (ICT) have constructed patent pools and other cross-licensing arrangements that allow innovation and commercialization to proceed even in patent-intensive environments. These arrangements not only mitigate or preclude the efficiency losses anticipated by conventional wisdom but can generate efficiency gains by reducing the price of accessing the pooled technology. These patent pools and related cross-licensing relationships underlie data compression and transmission technologies used in electronics devices that are fixtures of the digital economy: DVD players, Blu-ray players, Firewire and Bluetooth systems, WiFi systems, LAN systems, online streaming of audio and video files, digital television, satellite television, cable television set-top boxes and more.

This article delivers the most comprehensive existing documentation of the patent pools that operate in ICT markets and, in doing so, enriches our understanding of the transactional function played by patent pools in these markets. Understandably legal scholars tend to focus on judicial decisions and litigations. But these are occasional occurrences that are dwarfed by the mass of licensing transactions regularly and profitably engaged in by participants in technology markets. Research into the contractual agreements and organizational structures that drive technology markets is challenged by a wealth of information dispersed among multiple sources. Using network visualization software that has rarely been used in previous legal scholarship, I simplify this informational mass by constructing "maps" that identify the composition of every known patent pool and similar arrangements in ICT markets as well as the interrelationships among these pools and their members.[1] The scale of these patent networks is impressive, including hundreds of licensors-members, thousands of patents, and thousands of licensees. Take one of the oldest and most successful patent pools currently in operation. Launched in 1997, the MPEG-2 patent pool covers approximately 880 patents issued by 57 coun-

1. I am aware of one other use of network graphs with respect to patent pools. *See* Gavin Clarkson, Objective Identification of Patent Thickets: A Network Analytic Approach, *in* Essays on Intellectual Asset Management 74, 106 (June 2004) (unpublished doctoral thesis, Harvard Business School) (on file with Baker Library Historical Collections, Harvard University) (using network visualization software to depict citation-based relationships between patents in a pool). Professor Clarkson and a coauthor apply the same methodology to the nanotechnology industry. *See* Gavin Clarkson & David DeKorte, *The Problem of Patent Thickets in Convergent Technologies*, 1093 ANN. N.Y. ACAD. SCI. 180, 180–81 (2006). *See also* Rahul C. Basole, *Visualization of Interfirm Relations in a Converging Mobile Ecosystem*, 24 J. INFO. TECH. 144, 144–45 (2009) (using network visualization to document relationships among different types of firms in mobile digital communications markets).

tries,[2] includes 27 licensors in North America, Europe and East Asia, and licenses its technology to approximately 1,384 licensees.[3] Without knowing it, any consumer who uses a DVD player or Blu-ray player, watches high-definition television, or views an audio or video file on the internet likely has been using a technology that is covered by the MPEG-2 pool.

Legal and economics scholars have repeatedly lamented that technology markets are in danger of falling into, or have already fallen into, an "anticommons" or "thicket" of conflicting patent claims that unduly restrain innovation.[4] Government reports and officials repeat the same assertion.[5] However, a minority school of thought has emphasized the market's ability to anticipate and take efforts to preclude this outcome, relying primarily on evidence supplied by transactional structures in copyright-governed content markets.[6] The emergence of pooling and similar arrangements in patent-governed technology markets, combined with continuous robust R&D investment in those markets, tends to support the minority view. At least in ICT markets, key participants exhibit strong capacities for precluding or mitigating adverse effects on innovation that may result from intensive patent issuance and enforcement.

The normative implications of this evidence should not be overstated. At best, it counsels against wholesale dismissals of the patent system as nothing

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2. Bill Geary, *Patent Pools in High-Tech Industries*, INTELL. ASSET MGMT., Sept.–Oct. 2009, at 98–99 (providing data as of June 30, 2009).

3. All information accessed through MPEG LA website. MPEG LA, http://www.mpegla.com/main/programs/M2/Pages/Intro.aspx (last visited Nov. 10, 2014).

4. For the leading sources of this thesis in the legal literature, see MICHAEL A. HELLER, THE GRIDLOCK ECONOMY: HOW TOO MUCH OWNERSHIP WRECKS MARKETS, STOPS INNOVATION, AND COSTS LIVES (2008); Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621 (1998). For the most widely discussed contribution, see Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 Sci. 698 (1998) (according to Google Scholar, cited over 2,222 times as of Oct. 13, 2014). For other contributions in this vein, see, LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD (2001); MICHELE BOLDRIN & DAVID K. LEVINE, AGAINST INTELLECTUAL MONOPOLY (2008); Paul A. David, *Mitigating "Anticommons" Harms to Science and Technology Research*, 2 WIPO J. 59 (2010).

5. *See* FED. TRADE COMM'N, THE EVOLVING IP MARKETPLACE: ALIGNING PATENT NOTICE AND REMEDIES WITH COMPETITION 56 (2011), *available at* http://www.ftc.gov/sites/default/files/documents/reports/evolving-ip-marketplace-aligning-patent-notice-and-remedies-competition-report-federal-trade/110307patentreport.pdf; FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY 9–10 (2003), *available at* http://www.ftc.gov/sites/default/files/documents/reports/promote-innovation-proper-balance-competition-and-patent-law-and-policy/innovationrpt.pdf; Timothy J. Muris, Chairman, Fed. Trade Comm'n, Competition and Intellectual Property Policy: The Way Ahead, Remarks Before the American Bar Association, Antitrust Section Fall Forum (Nov. 15, 2001) (transcript available at http://www.ftc.gov/public-statements/2001/11/competition-and-intellectual-property-policy-way-ahead).

6. For the leading source, see Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CALIF. L. REV. 1293 (1996). For a more recent contribution in this vein, see Richard A. Epstein et al., *The FTC, IP, and SSOS: Government Hold-up Replacing Private Coordination*, 8 J. COMPETITION. L. ECON. 1 (2012). Both contributions ultimately trace back to Ronald Coase's fundamental insight that, subject to transaction-cost constraints, markets will rationally contract to converge on efficient property rights arrangements. *See* Ronald Coase, *The Problem of Social Cost*, 3 J. L. & ECON. 1 (1960).

but a socially costly rent-transfer mechanism. Even absent the patent deadlock anticipated by theory, there is still a credible risk that pooling arrangements may inflict a cure worse than the disease—namely, by enabling collusion among the members in any such arrangement. That risk motivated a quasi-prohibition of these structures by federal antitrust authorities from roughly the late 1930s until the early 1980s. I find little evidence to support collusion risk with respect to at least the patent pools administered in ICT markets by MPEG LA, the leading pool administrator. Based on pool composition, structure, pricing and other features, I argue that the MPEG LA patent pools are best understood as a mechanism by which intermediate users—in particular, vertically integrated hardware manufacturers—seek to *reduce* the price paid to access the technologies required to supply products and services to end users. The MPEG LA arrangements are open to all qualified "essential" patentees, are administered by a third-party entity on reasonable and nondiscriminatory (RAND) licensing terms, and include other precautions against collusion risk. When appropriately structured, patent pools can relieve the transaction-cost frictions inherent to the patent system and reduce the price of accessing the pooled technology. While the first benefit is clearly both a private and social gain, the second benefit is only potentially a social gain, for the surprising reason that patent pools may excessively reduce the returns enjoyed by technology providers.

The article is organized as follows. Part I, describes the economic forces that drive standardization and pooling arrangements that mitigate patent thickets in ICT markets. Part II uses network visualization to provide an empirical account of patent pools in ICT markets. Part III examines the key features and pricing effects of selected MPEG LA patent pools.

I. PATENT THICKETS: AN UNREALIZED RISK

Commentators have *theorized* that the large volume of issued patents and the associated increase in patent litigation, since the creation of the Federal Circuit in 1982, has resulted in "patent thickets" or "anticommons" that impede innovation through a combination of transaction costs and dispute-resolution costs.[7] Following this popular view, the global electronics industry would appear to be a market that is fertile ground for a patent thicket: leading devices consist of hundreds to thousands of components and, as a result, hundreds to thousands of patents can "read" on to a single device. But the facts suggest otherwise. There is little indication that the significant growth in patent issuance and litigation since the early 1980s has adversely affected R&D investment or product output or pricing in the consumer electronics markets.[8]

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7. *See* sources cited *supra* note 4.

8. For the most systematic empirical contribution that claims to find such adverse effects in innovation markets in general, see JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE: HOW JUDGES, BUREAUCRATS AND LAWYERS PUT INNOVATORS AT RISK (2008), who argue that the social-cost burden imposed by patent litigation now exceeds any increase in social wealth in the form of incremental innovation attributable to the availability of patent protection. As others have noted, this empirical claim relies on the assumption that short-term movements in the individual

To the contrary, on the "supply" side, private R&D spending in the U.S. computing and electronics industries has grown almost every year for the period 1998–2013[9]; and on the "demand" side, consumers of electronics goods have enjoyed an uninterrupted flow of new products, increasing output and declining prices during that same period.[10] Consider the computer industry: prices for computers and peripheral equipment have declined every year from 1995 through the present[11] while worldwide shipments of servers, desktops and laptops have increased from 1.1 million units in 1980 to an estimated 517 million units as of 2015.[12] The same pattern indicative of a healthy competitive market—declining prices and increasing output—repeats itself in other ICT segments: (1) worldwide shipments of smartphones increased from one-half billion units in 2011 to over one billion units in 2013;[13] (2) worldwide shipments of tablet computers increased from nothing in 2010 to slightly more than 200 million in 2013;[14] and (3) worldwide shipments of Bluetooth-enabled devices increased from zero in 2000 to approximately 2.5 billion units as of year-end 2013.[15] The worldwide electronics market has apparently avoided or significantly mitigated the patent thickets and associated inefficiencies, which should have emerged in multicomponent technology markets that have operated for an extended period under intensive patent issuance and enforcement.

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stock values of large public corporations provide a reliable proxy for the net general welfare effects of patent protection. *See, e.g.*, Rosemarie H. Ziedonis, *On the Apparent Failure of Patents: A Response to Bessen and Meurer*, 22 ACAD. MGMT. PERSPECTIVES 21 (2008). That assumption is tenuous: the large public-firm proxy partially ignores favorable "macro" effects on social welfare attributable to the patent system (for example, the development of secondary financing markets) and entirely ignores the effect of the patent system on smaller public firms and nonpublic firms. Given that the latter population often tends to be the most fertile source of R&D inputs, this is a significant omission.

9. *See* BOOZ & CO., NAVIGATING THE DIGITAL FUTURE: THE 2013 GLOBAL INNOVATION 1000 STUDY 13 (2013), *available at* http://www.strategyand.pwc.com/media/file/Strategyand_2013-Global-Innovation-1000-Study-Navigating-the-Digital-Future_Fact-Pack.pdf. As a percentage of firm revenues (R&D intensity), R&D expenditures have held constant throughout this period.

10. Jason Dedrick & Kenneth L. Kraemer, *Personal Computing*, *in* INNOVATION IN GLOBAL INDUSTRIES: U.S. FIRMS COMPETING IN A NEW WORLD 23, 41–42 (Jeffrey T. Macher & David C. Mowery eds., 2008). *See also* IBISWORLD, INDUSTRY REPORT: GLOBAL COMPUTER HARDWARE MANUFACTURING 6–7, 9 (2014) [hereinafter IBISWORLD, GLOBAL COMPUTER HARDWARE MANUFACTURING] (noting that prices for computer hardware have declined, resulting in thin profit margins for manufacturers); IBISWORLD, BUSINESS ENVIRONMENT REPORT: PRICE OF COMPUTERS AND PERIPHERAL EQUIPMENT (2014) [hereinafter IBISWORLD, BUSINESS ENVIRONMENT REPORT] (arguing the same).

11. *See* IBISWORLD, BUSINESS ENVIRONMENT REPORT, *supra* note 10, at 2.

12. *See Worldwide PC Market*, ETFORECASTS.COM, http://www.etforecasts.com/products/ES_pcww1203.htm (last visited Oct. 16, 2014).

13. *See* Press Release, Worldwide Mobile Phone Market Forecast to Grow 7.3% in 2013, IDC.COM (Sept. 4, 2013), http://www.idc.com/getdoc.jsp?containerId=prUS24302813. The numbers for 2013 are on an expected basis.

14. *See* Press Release, *IDC Forecasts Worldwide Tablet Shipments to Surpass Portable PC Shipments in 2013*, IDC.COM (May 28, 2013), http://www.idc.com/getdoc.jsp?containerId=prUS24129713 (forecasting 229.3 million shipments for 2013).

15. *SIG Membership*, BLUETOOTH.COM, http://www.bluetooth.com/Pages/SIG-Membership.aspx (last visited Oct. 19, 2014) (forecasting 2.5 billion shipments by the end of 2013).

A. Hold-Up Risk, Standards, and Pools

Patent pooling and cross-licensing arrangements in ICT markets take place as a reaction to two phenomena: (1) the proliferation of patent rights in a multicomponent technology environment, thereby *potentially* giving rise to the transaction costs and pricing inefficiencies associated with patent thickets; and (2) the inherent convergence of ICT markets toward a single or a limited number of standards in any given technological field. ICT markets demand standards because communications technologies are inherently network goods: that is, the value of the technology increases as a function of the number of users of that *same* technology. A cellular system with a single subscriber has little value; the same system with hundreds of millions of subscribers has great value. Hence users demand either a single standard or interoperability among multiple standards. But the inherent convergence on a single standard poses an obstacle to persuading users, as well as outside suppliers of complementary inputs, to make the investments required to adopt any nascent standard. The reason is hold-up risk.[16] Any user or other entity that must make an investment "specific" to a new standard (that is, an investment that will have no or lesser value in any other use) anticipates that, once the standard has been adopted, the entity that controls the standard will adjust the terms of access to expropriate the value of that investment. By anticipation, the user declines to invest, the standardization process is blocked or delayed, and network gains from mass adoption are suppressed.

However, the hold-up story is not realized: standards have been widely adopted in technology markets and users and suppliers regularly make significant investments in those standards. Our analytical task is therefore to explain how the market has reached this outcome, even if that appears unlikely as a matter of theory.

1. *Standardization Mechanisms*

Successful technology markets must devise a mechanism to address hold-up risk, induce adoption of technology standards, and enjoy the resulting network effects. There are three possible mechanisms by which to do so.

a. State Monopolist

A single governmental (or governmentally authorized) standard-setting agency sets a standard by force of law. For example, the Federal Communications Commission set various standards for television manufacturers and broadcasters in the transition from analog to digital television.

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16. For the seminal source on hold-up risk, see OLIVER WILLIAMSON, MARKETS AND HIERARCHIES: ANALYSIS AND ANTITRUST IMPLICATIONS (1975). On hold-up risk in the standard-setting context, see Jorge L. Contreras, *Fixing FRAND: A Pseudo-Pool Approach to Standards-Based Patent Licensing*, 79 ANTITRUST L. J. 47, 48 49 (2013) [hereinafter Contreras, *Fixing FRAND*].

b. Market Monopolist

A single firm is the monopoly provider of a standardized technology. The "Wintel" market offers a duopolistic variant of this scenario: in the personal computer market, Microsoft supplies the dominant standard for the operating system while Intel supplies the dominant standard for the microprocessor.

c. Market Association

A voluntary market-based association that sets a single technological standard to which multiple providers conform, sometimes subject to payment of a royalty. This describes DVD, Bluetooth, WiFi and other technologies that were standardized by an industry consortium but are available for licensing by all parties willing to pay the required royalty.

2. *Market-Based Standardization in ICT Environments*

Contemporary ICT markets have widely adopted the *Market Association* option as the preferred instrument by which to achieve standardization and hence interoperability in nascent technology segments. Voluntary associations and consortia, as distinguished from formal accredited standard-setting bodies (often empowered by a governmental mandate, making them closer to the *State Monopolist* option), are increasingly the most common instrument by which technology markets converge on standardized protocols, methods or processes.[17] Some of the leading formal and informal standardization bodies are listed in Table 1 below. This alphabet soup of technology standards lies behind the communications and data processing devices that have become a part of everyday experience.

Table 1. Selected Standardization Entities in ICT Markets

Formal	Informal-Ad Hoc
International Organization for Standardization (ISO)	Internet Engineering Task Force (IETF)
International Electrotechnical Commission (IEC)	European Telecommunications Standards Institute (ETSI)
Motion Picture Experts Group (MPEG)	World Wide Web Consortium (W3C)
International Telecommunications Union (Telecommunications) (ITU-T)	Bluetooth SIG
Institute of Electrical and Electronics Engineers (IEEE)	DVD3C
Society of Motion Picture and Television Engineers (SMPTE)	DVD6C
	WiFi Alliance

17. *See* Carl Cargill, *Uncommon Commonality: A Quest for Unity in Standardization*, *in* THE STANDARDS EDGE 29 (Sherrie Bolin ed., 2002); Linda Garcia, *Standards for Standard Setting: Contesting the Organizational Field*, *in* THE STANDARDS EDGE: DYNAMIC TENSION 15, 22 23, (Sherrie Bolin ed., 2004).

3. *Hold-Up Risk and Organizational Design*

Like any other standardization solution, a *Market Association* must adopt some mechanism by which to address hold-up risk, which will otherwise slow down user adoption. Without some protection against hold-up risk, both the supply side and demand side of the standard-setting market are likely to stall. On the demand side, potential adopters are discouraged from investing resources in a newly developed standard ex post; by anticipation, on the supply side, potential developers are discouraged from investing resources in establishing and implementing the standard ex ante. A large literature has documented how SSOs anticipate this hold-up contingency and seek to resolve it.[18] Broadly speaking, there are three possible solutions, each of which is imperfect in some respect.

a. Royalty-Free Requirement

The SSO can insist that all components of the standard must either be free from any patent claims or, if any claims exist, the holder must commit to license the patent on a royalty-free basis. This aggressive requirement limits the universe of potential contributors to the pool and is therefore often not feasible. Some evidence shows that SSOs infrequently impose such a requirement.[19]

b. Disclosure Requirement

The SSO can require that each firm or other entity that participates in the standard-setting process commit to disclose its patents that are "essential" to the standard. This is a commonly adopted requirement[20] but can have limited practical force because of disagreement over the scope of "essential patents"[21] or the appropriate time at which disclosure is required. While minimizing hold-up risk would recommend accelerating the point of disclosure, firms are reluctant to release private information until it is clear that a standard is likely to be agreed upon and to achieve market acceptance.

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18. For leading contributions, see Benjamin Chiao et al., *The Rules of Standard-Setting Organizations: An Empirical Analysis*, 38 RAND J. Econ. 905 (2007); Mark Lemley, *Intellectual Property Rights and Standard-Setting Organizations*, 90 CALIF. L. REV. 1889 (2002).

19. *See* Chiao et al., *supra* note 18, at 917 tbl.1, 921 n.29. Other evidence, based on a sample of technological standards identified in a representative laptop computer, identify a significant percentage of standards that are disseminated following a royalty-free model. *See* Brad Biddle et al., *How Many Standards in a Laptop? (And Other Empirical Questions)* (Ariz. State Univ., Working Paper, 2010), *available at* http://ssrn.com/abstract=1619440 (showing 22% follow a royalty-free model).

20. *See* Chiao et al., *supra* note 18, at 918 tbl.1, 921 n.29; Biddle et al., *supra* note 19.

21. To address some of these difficulties, SSOs sometimes retain an independent expert to identify essential patents held by participants or other entities. *See* Therese Hendricks et al., *Role Reversal: A Step Toward Resolving IP Disclosure Problems by Establishing an SSO Search Policy*, *in* THE STANDARDS EDGE 290 (Sherrie Bolin ed., 2002).

c. RAND Licensing Requirement

An SSO can choose to condition inclusion in the relevant standard of any entity's technology on the entity's having agreed to license its standard-essential patents to all interested parties on "reasonable and nondiscriminatory" terms (RAND).[22] SSOs commonly adopt this requirement.[23] The practical force of the RAND commitment varies, depending on whether it is set forth in the SSO's bylaws or in a licensing agreement between the SSO and each member.[24] Even in the latter case, which provides a more secure litigation target, the RAND commitment may still have limited effect for three reasons. First, the precise meaning of the RAND commitment is typically not defined by the SSO, and there is no consensus standard to objectively determine it after the commitment has been made.[25] As a result, litigation has periodically ensued over the meaning of the RAND commitment and whether a patent holder has complied with it.[26] Second, the "essential" patents (or patent claims) to which the RAND commitment applies are not always clearly defined.[27] Third, because of nondisclosure agreements, it is often not possible to

22. *See* LARRY M. GOLDSTEIN & BRIAN N. KEARSEY, TECHNOLOGY PATENT LICENSING: AN INTERNATIONAL REFERENCE ON 21ST CENTURY PATENT LICENSING, PATENT POOLS AND PATENT PLATFORMS 26–27 (2004); Tiejun Huang, *A New Approach for Developing Open Standards with a More Reasonable Patent Licensing Policy*, *in* THE STANDARDS EDGE: FUTURE GENERATION 218–20 (Sherrie Bolin ed., 2005). The alternative term, "FRAND" (fair and reasonable nondiscriminatory) licensing is sometimes used.

23. *See* Chiao, *supra* note 18, at 918 tbl.1; 921 n.29.

24. *See* Mark A. Lemley, *Ten Things To Do About Patent Holdup of Standards (and One Not To)*, 48 B.C. L. Rev. 149, 157 (2007).

25. *See* GOLDSTEIN & KEARSEY, *supra* note 22, at 38–40; Jorge Contreras, *Technical Standards and* Ex Ante *Disclosure: Results and Analysis of an Empirical Study*, 53 JURIMETRICS J. 163, 167 (2013); Mark Lemley, *Intellectual Property Rights and Standard Setting Organizations*, 90 CALIF. L. REV. 1889, 1957–58 (2002). Standard-setting organizations typically refrain from defining the RAND commitment ex ante because of antitrust concerns, as well as concerns about limiting members' licensing freedom and the difficulty in forecasting licensing rates and updating rates in response to changed circumstances. For similar observations, see Contreras, *Fixing FRAND*, *supra* note 16, at 51–52. Actual evidence on litigation exposure on this point is limited and mixed. In one case, a SSO was exposed to antitrust liability as a result of prestandard-setting licensing discussions. *See* Sony Elecs., Inc. v. Soundview Techs., Inc., 281 F. Supp. 2d 399 (D. Conn. 2003). However, in 2006, the Department of Justice granted a nonadverse business review letter to a standard-setting organization that indicated it would require its members to indicate ex ante their maximum royalty rate for patents covering technologies that had been declared essential to the standard. *See* Letter from Thomas O. Barnett, Assistant Attorney Gen., Dep't of Justice, to Robert A. Skitol, Esq., Drinker, Biddle & Reath, LLP, on behalf of VMEbus International Trade Association (VITA) (Oct. 30, 2006), *available at* http://www.justice.gov/atr/public/busreview/219380.pdf. Later antitrust regulators indicated that they might tolerate ex ante agreements on licensing rates. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, ANTITRUST ENFORCEMENT AND INTELLECTUAL PROPERTY RIGHTS: PROMOTING INNOVATION AND COMPETITION 52 (2007).

26. For the most complete review of FRAND-related litigation, see Contreras, *Fixing FRAND*, *supra* note 16, at app.

27. *See* Chiao et al., *supra* note 18, at 921. Litigation has periodically ensued over these issues. *See, e.g.*, Lotes Co. v. Hon Hai Precision Indus. Co., No. 12 Civ. 7465(SAS), 2013 WL 2099227, *11 (S.D.N.Y. May 14, 2013), *aff'd on other grounds*, 753 F.3d 395 (2d Cir. 2014) (dismissing antitrust and breach of contact claims against FoxConn, a component supplier that allegedly violated its RAND commitment to the USB standardization body); Intel Corp. v. VIA Tech., 174 F. Supp. 2d 1038, 1044–45 (N.D. Cal. 2001) (litigation concerning whether licensing

observe the terms under which a patent holder has licensed its technology to a third party,[28] making it difficult to verify compliance with the RAND commitment.

4. *The Patent Pooling Solution*

In some market segments, the *Market Association* option described above has evolved to address hold-up risk more fully. In those cases (which will be the focus of this article), patent holders have moved from (1) standard-setting activities with an ambiguously enforceable RAND commitment as described above, to (2) patent pool arrangements with a certainly enforceable set of terms and conditions. Relative to a standardization entity, a patent pool more fully addresses hold-up risk insofar as every contributing entity assigns (usually nonexclusively and subject to contractual conditions) to a collective entity the right to issue licenses to the intellectual property (IP) it contributes to the pool.[29] In lieu of the vague RAND commitment that lacks any clear enforcement mechanism (and, in some cases, any clear litigation target), a patent pool can offer licensees a defined package of IP assets that implements a technological standard and, by setting forth a known licensing rate (and other terms and conditions), significantly reduces hold-up risk.[30]

Table 2 identifies some of the most prominent pooling arrangements in ICT markets.[31] While patent pools only govern a small minority of the total mass of technological standards in ICT markets,[32] these pools are commercially significant insofar as they cover important data compression, data dissemination and other technologies commonly found in consumer electronics devices. In each case listed below, the two-part sequence set forth above has been followed: a formal or informal standardization body set the technology standard and a pooling entity then emerged to administer some of the patents pertaining to the standard. Broadly speaking, these arrangements can be categorized among four technology areas:

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commitment to SSO pertained only to basic features of the standard or included certain extensions of the standard), *aff'd* 319 F.3d 1357 (Fed. Cir. 2003).

28. *See* GOLDSTEIN & KEARSEY, *supra* note 22, at 33.

29. This is at least partially so because typically, due to antitrust concerns, contributing entities retain the right to license out their IP independently of the pool.

30. Note that the hold-up risk cannot be entirely eliminated given (1) the impossibility of being certain that all holders of relevant patents are licensors-members in the pool, (2) the incentives of some holders to conceal their ownership of a standard-essential patent, and (3) subject to contractual constraints, the ability of pool members to withdraw from the pool.

31. For a full list, see *infra* Appendix A.

32. *See* Biddle et al., *supra* note 19 (based on sample of interoperability standards found in a representative laptop computer, finding that only a small percentage are governed by a patent pool); Contreras, *Fixing FRAND*, *supra* note 16, at 76–78 (observing that most technological standards are not governed by patent pools).

(1) "codec" software for compressing audio, visual or other data for purposes of storage and wireless transmission;

(2) technologies for "near field" wireless transmission of audio, visual or other data;

(3) technologies for long-distance wireless transmission; and

(4) technologies for compressing visual data on digital video discs (DVDs) and "displaying" that data through DVD and Blu-ray players.

Modern pooling arrangements achieved their first success in the case of an industry consortium formed by small groups of electronics manufacturers in the early 1990s to license patents relating to CD technology (administered by Philips[33]) and, then in the late 1990s, in the case of two industry consortia (the DVD3C and DVD6C pools, administered by Philips and Toshiba, respectively) established to launch the DVD format. Today pooling arrangements are probably most well known in the case of "codecs," which are software programs for encoding (also known as "compressing") and decoding the rich data embedded in a digital "packet" of audio and visual information so that it can be efficiently transmitted by the sender's device and then received and displayed by the recipient's device.[34] Data compression is an essential step in enabling large amounts of complex video, audio, and other data to be stored and transmitted more efficiently than would otherwise be possible. This in turn allows for widespread uses of the DVD, the Blu-ray disc, the iPhone and iPad devices, certain functions of cable set-top boxes, and online audio and video streaming. Adoption of standardized codec technologies unleashes a virtuous snowball effect of innovation, production and distribution. Given establishment of the standard, hardware manufacturers invest in making compatible data production, storage and transmission devices, chip manufacturers invest in making the chips for use in audio and video display devices, and telecommunications carriers invest in establishing the network infrastructure required for wireless communications.[35] With that complex and expensive infrastructure set in place by intermediate users, individual and business end users are prepared to complete the loop by purchasing the necessary devices and media at the final point of sale, which delivers the revenue streams required to cover the expenditures incurred to undertake all of the foregoing steps.

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33. For a description, see U.S. Philips Corp. v. Int'l Trade Comm'n, 424 F.3d 1179, 1182 (Fed. Cir. 2005).

34. The MPEG standards provide agreed-upon formats for the data that are processed by codec software. This software enables interoperability across hardware made by different manufacturers so long as the encoding and decoding devices comply with the standardized compression method. For further discussion, see PHILIP J. CIANCI, HDTV AND THE TRANSITION TO DIGITAL BROADCASTING: UNDERSTANDING NEW TELEVISION TECHNOLOGIES 36–37, 59 (2007); JOHN WATKINSON, THE MPEG HANDBOOK (2d ed. 2004); Marios C. Angelides & Harry Agius, *MPEG Standards in Practice, in* THE HANDBOOK OF MPEG APPLICATIONS: STANDARDS IN PRACTICE 1 (Marios C. Angelides & Harry Agius eds., 2011).

35. *See* Rick Merritt, *How HEVC Could Remake Internet Video — Or Not*, EETIMES (Jan. 25, 2013), http://www.eetimes.com/author.asp?section_id=36&doc_id=1266337.

Table 2. Selected Standard-Pool Pairs in ICT Markets (1995–Present)[36]

Standard	Standard-Setting Entity	Pooling Entity	Product Category
Video and audio data compression ("codecs")			
MPEG-2	ISO/IEC-MPEG	MPEG-LA	Video codec. Used in cable TV set-top boxes, DVD players and discs, video recorders, digital cameras, Blu-ray players and discs, digital television and high-definition television.
MPEG-4 Visual	ISO/IEC-MPEG	MPEG-LA	Video codec. Used in digital media players, mobile phones, video cameras, internet services.
H.264 (MPEG-4 Part 10, or AVC)	ISO/IEC-MPEG (AVC); ITU-T (H.264)	MPEG-LA	Video codec. Used in Blu-ray and DVD players and discs, mobile broadcast video, portable game consoles, high-definition satellite TV. Used in HTML5.
VC-1	SMPTE 421M-200	MPEG-LA	Video codec. Used in Blu-ray discs. Alternative to H.264 standard.
AAC	ISO/IEC-MPEG	Via Licensing	Audio codec. MP3 technology.
Near-field wireless data transfer			
Bluetooth	Bluetooth SIG	Bluetooth SIG	"Near field" wireless communication
WiFi (802.11)	IEEE	Via Licensing	Wireless local area networks (LAN)
1394 (Firewire)	IEEE	MPEG-LA	Serial bus interface standard for data transfer
Blu-ray, DVD/CD players and discs			
Blu-ray	Blu-ray Disc Assoc.	One-Blue	Blu-ray players, discs
Blu-ray	Blu-ray Disc Assoc.	Premier BD	Blu-ray players, discs

36. All acronyms are defined in Table 1. Note that MPEG LA is a body that specializes in the formation and maintenance of patent pools; it is entirely distinct from MPEG, which is a standardization body that operates under the auspices of the ISO/IEC standardization bodies.

Standard	Standard-Setting Entity	Pooling Entity	Product Category
DVD	DVD Forum	Philips/One-Red	DVD players, discs
DVD	DVD Forum	Toshiba	DVD players, discs

B. Pool Architecture

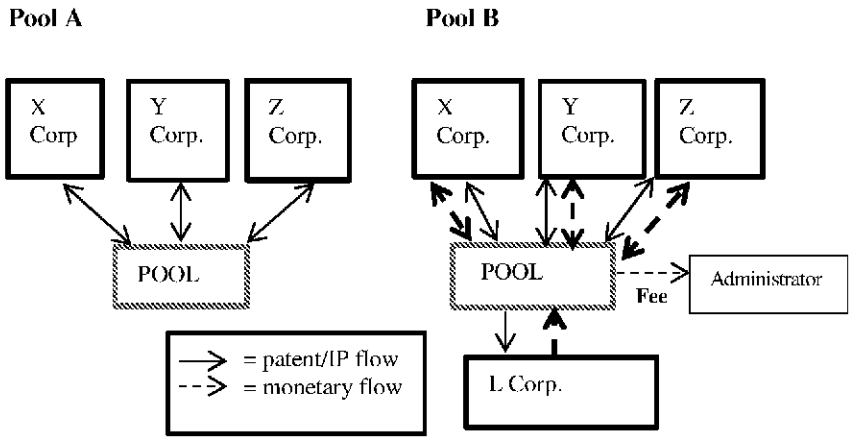
The combination of network effects and hold-up risk explains why ICT markets have developed patent pooling arrangements as a complement to standardization arrangements. These two structures are the precondition for unleashing the massive network gains generated by mature technology markets: first, by establishing a common standard, and second, by establishing a transactional mechanism that protects against opportunistic hold-up behavior. Before launching into a detailed discussion of specific pooling arrangements in ICT arrangements, a few final steps are in order. Namely: we must define what we mean by "patent pool" and identify the building blocks that are available to construct a patent pool. "Patent pool" is often used generically to describe various cross-licensing arrangements that may have markedly different features, ranging from a simple cross-licensing arrangement between two entities with blocking patent positions to complex multilateral licensing arrangements involving tens of thousands of IP holders. To describe patent pools and similar arrangements more precisely, and to appreciate the reasons behind observed differences in pool design, it is necessary to identify some basic parameters by which to distinguish different pools.

At the most general level, any patent pool can be categorized by reference to three parameters: (1) directional relationship (*vertical*; *horizontal*); (2) asset flows (*IP*; *monetary royalties*); and (3) management function (*internal; external*). With respect to the first and second parameters, there will always be a horizontal relationship among the licensors-members in the pool who typically contribute patents or other IP assets to the pool in exchange for access to other members' patents or other IP assets (and, if relevant, a side-payment to reflect differences in the value of each member's IP contribution). In some cases, there will also be a vertical relationship between the pool and its licensees, who pay monetary royalties to the pool, which then allocates those royalties to the pool members. With respect to the third parameter, management of the pool can either be implemented internally by the members or externally by a third-party administrator, in which case a transaction fee must be paid for its efforts.

As illustrated below, the vertical-horizontal parameters can be used to anticipate two idealized structures: (1) *Pool A,* a pool with a horizontal relationship but no vertical relationship (that is, no licensees); and (2) *Pool B,* which comprises both vertical and horizontal components, although one com-

ponent may be "stronger" than the other in any particular case.[37] Each of these pool types can then combine different types of IP and monetary asset flows in various proportions and can select from internal or external management mechanisms. IP asset flows are indicated by solid lines; dollar asset flows are indicated by dashed lines. Note that *Pool A* contemplates a zero-royalty pool, presumably because the two contributing entities have contributed roughly equally valued IP assets into the pool. *Pool B* contemplates use of an external management entity and payment of a royalty by licensees (which may include licensors) with respect to the patent pool.

Figure 1. Idealized Pooling Structures



C. The New Pools: Organizational Innovation in Technology Markets

Using the concepts and terminology introduced above, we are now in a position to review the evolution of pooling structures in U.S. technology markets.

1. *The Revival of Patent Pools.*

Patent pools and similar cross-licensing arrangements were a common feature of U.S. industrial organization during approximately the first third of the 20th century. From the late New Deal through the early 1950s, however, numerous pools were significantly modified or dismantled as a result of antitrust prosecutions and perceived liability exposure. Few companies dared to form new patent pools for several decades. Several developments reduced that risk: (1) starting in the early 1980s, the courts' progressive rejection of "per

37. Pool A and Pool B both contemplate three licensors. This is because I define patent pools as consisting of a minimum of three members to distinguish pools from the much larger mass of bilateral patent licensing arrangements.

se" liability standards in antitrust jurisprudence; (2) statutory safe harbors for certain cooperative activities established in 1984 and 1993;[38] and (3) revised regulatory guidelines for licensing and collaborative activities adopted by the antitrust agencies in 1995 and 2000.[39] Most importantly, in 1997, 1999 and 2002, the Antitrust Division of the Department of Justice issued "business review letters" that indicated "no intention to prosecute" several proposed patent pools.[40]

In response to these legal signals, ICT markets have experienced a reemergence of patent pools and similar structures since the late 1990s.[41] The current frequency with which patent and other IP pools are being formed in ICT markets—roughly two per year since 1995—is only matched historically by the frequency rates observed about a century earlier from the early 20th century through the 1930s (at which time the New Deal administration promoted cartel formation as explicit industrial policy).

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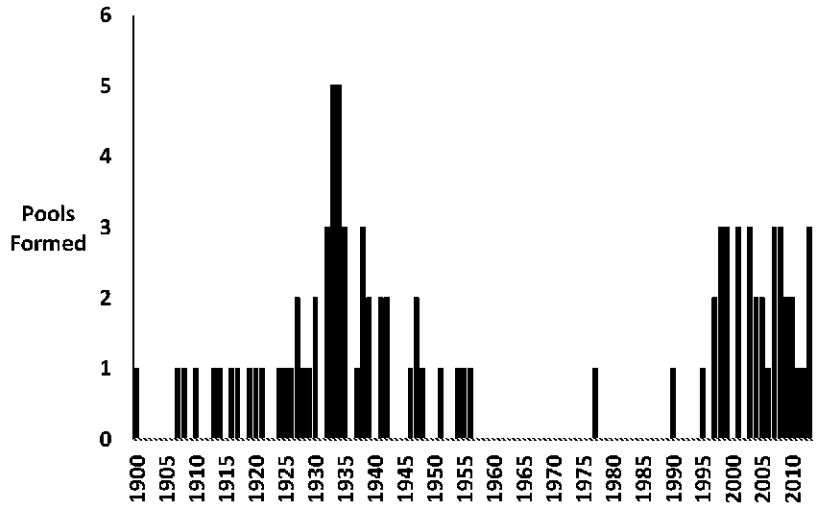
38. *See* National Cooperative Research Act of 1984, 15 U.S.C. §§4301–4306, which was amended by the National Cooperative Research and Production Act of 1993. Under the Act, antitrust liability is limited to actual, rather than treble damages, so long as the parties file a notification with the FTC and DOJ within ninety days of formation of the joint venture. Subsequent legislation has expanded the safe harbor for cooperative research, marketing and standards development activities. *See* Standards Development Organization Advancement Act of 2004, Pub. L. No. 108–237, 118 Stat. 661. Other guidance can be found in DEP'T. OF JUSTICE & FED. TRADE COMM'N, ANTITRUST GUIDELINES FOR COLLABORATIONS AMONG COMPETITORS (2000); FED. TRADE COMM'N, COMPETITION AND INTELLECTUAL PROP. LAW & POLICY IN THE KNOWLEDGE-BASED ECONOMY (FTC, DOJ HEARINGS 2002); DEP'T. OF COMMERCE, STANDARDS AND COMPETITIVENESS—COORDINATING FOR RESULTS: REMOVING STANDARDS-RELATED TRADE BARRIERS THROUGH EFFECTIVE COLLABORATION (2004), *available at* http://www.ita.doc.gov/td/standards/Final%20Site/Standards%20and%20Competitiveness.pdf.

39. *See* DEPT. OF JUSTICE & FED. TRADE COMMISSION, ANTITRUST GUIDELINES FOR THE LICENSING OF INTELLECTUAL PROPERTY (Apr. 5, 1995), *reprinted in* 4 TRADE REG. REP. (CCH) ¶ 13,132; DEP'T. OF JUSTICE & FED. TRADE COMMISSION, ANTITRUST GUIDELINES FOR COLLABORATIONS AMONG COMPETITORS (2000), *available at* http://www.ftc.gov/sites/default/files/documents/public_events/joint-venture-hearings-antitrust-guidelines-collaboration-among-competitors/ftcdojguidelines-2.pdf; DEP'T. OF JUSTICE & FED. TRADE COMMISSION, ANTITRUST GUIDELINES FOR THE LICENSING OF INTELLECTUAL PROPERTY (1995), *available at* http://www.justice.gov/atr/public/guidelines/0558.pdf.

40. Business review letters issued by federal antitrust regulators in 1997, 1999, and 2002, respectively, indicated no intention to take enforcement action with respect to the MPEG-2 patent pool, the DVD patent pool and the 3G patent platform partnership. *See* Letter from Charles A. James, Assistant Attorney Gen., Antitrust Div., Dep't of Justice, to Ky P. Ewing (Nov. 12, 2002), *available at* http://www.justice.gov/atr/public/busreview/200455.pdf (business review letter with respect to 3G Patent Platform Partnership); Letter from Joel I. Klein, Acting Assistant Attorney Gen., Antitrust Div., Dep't of Justice, to Gerrard R. Beeney, Esq. (June 26, 1997), *available at* http://www.justice.gov/atr/public/busreview/215742.pdf (business review letter with respect to MPEG-2 patent pool); Letter from Joel I. Klein, Acting Assistant Attorney Gen., Antitrust Div., Dep't of Justice, to Carey R. Ramos, Esq., (June 10, 1999), *available at* http://www.justice.gov/atr/public/busreview/2485.pdf (business review letter with respect to DVD patent pool). For details on the business review letter procedure, see 28 C.F.R. § 50.6 (2010), *available at* http://www.gpo.gov/fdsys/pkg/CFR-2010-title28-vol2/pdf/CFR-2010-title28-vol2-sec50-6.pdf).

41. In a companion paper, I have compiled what I believe to be the most comprehensive existing list of all documented cases of patent pools since 1900. *See* Jonathan M. Barnett, *The Anti-Commons Revisited* 55 62 (U.S.C., Working Paper, 2014) (draft) [hereinafter Barnett, *Anti-Commons*].

Figure 2. IP Pools Formed (1900–2013)[42]



2. *Old Pools and New Pools*

The revival of patent pooling is not only a quantitative shift. There appear to be some key qualitative differences in the organizational structures adopted by the cluster of pools formed during the early decades of the twentieth cen-

42. For the purposes of Figure 2, I included any horizontal arrangement in which three or more entities agreed to cross-license intellectual property pursuant to a contractual agreement or to aggregate intellectual property assets in a single new entity. I excluded (1) vertical licensing arrangements solely involving a single firm that licenses out a pool of patents, (2) mergers; (3) agreements between a standard-setting organization and a patentee whereby the latter agrees to license its "essential" IP on "reasonable and nondiscriminatory" terms; and (4) any agreement that only involves foreign markets. Even subject to those limitations, this list is incomplete insofar as it does not include some pools or similar arrangements that were not litigated, did not result in a court decision or were not mentioned in the sources I consulted. To compile this list, I included pools (subject to the definitional criteria described above) mentioned in the following contributions: FLOYD L. VAUGHAN, THE UNITED STATES PATENT SYSTEM: LEGAL AND ECONOMIC CONFLICTS IN AMERICAN PATENT HISTORY 62–63 (1956); Richard J. Gilbert, *Antitrust for Patent Pools: A Century of Policy Evolution*, 2004 STAN. TECH. L. REV. 3; Clarkson, *supra* note 1; Josh Lerner et al., *Cooperative Marketing Agreements Between Competitors: Evidence from Patent Pools* (Nat'l Bureau of Econ. Research Working Paper No. 9680, 2003) *available at* http://www.nber.org/ papers/w9680.pdf; Ryan Lampe & Petra Moser, *Patent Pools, Competition, and Innovation—Evidence from 20 U.S. Industries under the New Deal* (Stanford Law & Econ, Working Paper No. 417, 2014), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract id= 1967246##. I confirmed the existence of those pools and identified additional pools through the following sources: (1) the Westlaw database of federal judicial decisions; (2) *Investigation of Concentration of Economic Power: Hearings on Public Resolution No. 113 Before the Temp. Nat'l Econ. Comm.*, 75–76th Cong. (1939); (3) *Pooling of Patents: Hearings Before the H. Comm. on Patents*, 74th Cong., 1st Sess. (1935); (4) *Patents: Hearings on S. 2303 Before the S. Comm. on Patents*, 77th Cong., 2d Sess. (1942); and (5) the Proquest historical newspapers database.

tury and the organizational structures adopted by the cluster of pools formed during the late twentieth and early twenty-first centuries. The "old" pools tended to consist of cross-licensing arrangements entered into by a limited number of patent holders or, less frequently, a single corporation or association to which the patent holders had contributed their patents. This roughly corresponds to *Pool A* in the Figure above. These pools were sometimes closed structures that cross-licensed the pooled technology among its members, rather than licensing it to all interested downstream users, and were typically administered directly or indirectly by the licensors-members.[43] A purely or predominately horizontal structure raises concerns that it implements collusive restraints and erects a barrier to entry into the downstream market by entities that require access to the pooled technology. By contrast, the "new" pools consist mostly of cross-licensing arrangements that have a significant vertical component and are coordinated and administered by a third-party entity that does not operate in the downstream product market. This roughly corresponds to *Pool B* in Figure 2 above. The administrator licenses out the pooled technology to a large base of downstream users, earns an administrative fee on the licensing transactions, and funnels the remaining royalty stream to the pool members according to an allocation formula. In a variant on this structure, leading firms have sometimes formed consortia to administer patent pools; even in those cases, however, the consortium commits to RAND licensing practices that maintain a significant vertical component resulting in widespread licensing into the downstream market. While these types of structures have existed for several decades in licensing markets for music performance rights (e.g., organizations such as the American Society of Composers, Authors and Publishers (ASCAP) and Broadcast Music, Inc. (BMI)), it constitutes an organizational innovation in patent-governed technology markets.

Modern pool administrators in ICT markets have assembled impressively sized patent pools, as measured by the number of licensors, licensees, and patents. This impression must be qualified by the fact that there is limited information available on some pool administrators or consortia and, with respect to all administrators and consortia, there is no precise information available on the royalty revenue collected by those entities. Set forth below are available data on pooling and similar intermediaries that are currently known to be active in ICT markets including both independent entities that administer pools and consortia that are administered by an industry group.

43. For purposes of a companion paper, I am undertaking a pool-by-pool inquiry to identify precisely the extent to which these pools engaged in vertical licensing and the governance arrangements used in these pools. *See* Barnett, *Anti-Commons, supra* note 41.

Table 3. Patent Pool Intermediaries and Consortia in ICT Markets (1995–Present)[44]

Pool Intermediary	First Pool Formed	Total Pools	Total Licensors	Total Licensees[45]
Pools				
MPEG-LA	1997	9	160	4374
SISVEL	1997	8	38	c.1943*
Sipro Lab Telecom	1998	5	33	c. 223*
Via Licensing	2003	8	61	c. 1561*
VoiceAge[46]	2004	3	12	n/a
Consortia				
Bluetooth SIG	1998	1	7[47]	>20000
DVD3C (One-Red)	1998	1	4	551[48]
DVD6C	1999	1	9	467[49]
Premier BD	2010	1	6	47[50]
One-Blue	2011	1	15	60[51]

44. Unless otherwise indicated, all information is current as of July 8, 2014 and sourced from website for each pool or consortium. Notes: (1) n/a means the information was not available through the pool administrator or other sources; and (2) the number of licensors and licensees do not refer to *unique* licensors and licensees—that is, if a firm is a licensor or licensee in more than one pool administered by the same intermediary, it will be counted multiple times. Note further that I use the definition of patent pools as set forth previously – namely, any horizontal arrangement in which three or more entities agreed to cross-license intellectual property pursuant to a contractual agreement or to aggregate intellectual property assets in a single new entity. For that reason, I do not include certain licensing arrangements that are administered by the entities indicated above and are sometimes described as pools by the administrator or other commentators.

45. A starred entry means that the indicated number of licensees may be an underestimate because the administrator does not specify the complete number of licensees for all its pools.

46. VoiceAge is a spinoff of Sipro Lab Telecom. *See* VOICEAGE.COM, http://www.voiceage.com/COMPANY.html (last visited Oct. 2, 2014). The number of licensors is based on trade press sources and archived data from an earlier VoiceAge website.

47. For this purpose, I treat Promoter Members, the highest class of membership in Bluetooth SIG, as equivalent to a licensor. As a condition to membership, each Promoter must enter into a reciprocal, zero-royalty license agreement with respect to any patents it may have related to the Bluetooth standard. For more information, see *Membership Agreements*, BLUETOOTH.ORG, https://www.bluetooth.org/en-us/members/membership-agreements (last visited Oct. 19, 2014).

48. *See* Simon den Uijl et al., *Managing Intellectual Property Using Patent Pools: Lessons from Three Generations of Pools in the Optical Disc Industry*, 55 CALIF. MGMT. REV., Summer 2013, at 31, 37 tbl.1 (2013).

49. *See id.*

50. *Licensee List*, PREMIER-BD.COM, http://www.premier-bd.com/licensee.html (last updated July 23, 2014). The number of licensees may be underestimated because some licensees are not listed at the licensee's request.

51. *Licensees*, ONE-BLUE.COM, http://www.one-blue.com/licensees/ (last visited Oct. 9, 2014).

3. *Factors Behind the New Pools*

Three primary factors drive the recent emergence of third-party pool administrators as solutions to potential thicket problems in patent-intensive technology markets.

a. Antitrust Risk

This switch reflects the fact that antitrust law continues to impose liability risk for a significant portion of the possible transactional structures by which firms can cooperate to license out a pooled group of patents. In particular, the guidance provided by case law, agency guidelines and business review letters indicates that antitrust risk is minimized when patent pools satisfy the following requirements: (1) the pool covers patents that are complementary to, rather than being substitutes for, one another; (2) the pool licenses its patent portfolio to all interested parties on reasonable and nondiscriminatory terms; (3) the pool makes membership in the pool available only to parties with patents deemed "essential" to the standard (with essentiality being determined by an individual or entity that is independent of the contributing parties); (4) the pool enables each member to license its patents independently (that is, the license to the pool is always nonexclusive); and (5) the pool does not restrain or otherwise influence any licensor's or licensee's pricing and output decisions in the relevant product market.[52] The market logically responds to this guidance by moving toward structures with a robust vertical dimension, transparent and uniform licensing policies, and a neutral third party to coordinate among patent holders and independently set the pricing of patented technologies.

b. Hold-Up Risk

Using a third-party administrator is not only prudent legal policy, it represents a sensible business policy for the purpose of promoting adoption of the underlying technological platform. This in turn enables a licensor to earn returns on the sales of products and services that are complementary to that platform. Engaging a neutral third party enables licensors to commit more credibly to licensees that the licensors will not subsequently take advantage of the fact that licensees will have made difficult-to-reverse investments in the patented technology. The third-party administrator's commitment derives from the fact that, unlike the pool's licensors-members, it does not compete in the downstream product market and therefore has no strategic incentive to limit access into that market. Operational entities have multiple sources of rents that can be enjoyed as a result of forming the pool, some of which may be enhanced by elevating the royalty payment, which limits the size of the licensee base but inhibits entry into the downstream market. Suppose the pool granted

52. For a full review, see U.S. DEP'T. OF JUSTICE & FED. TRADE COMM'N, ANTITRUST ENFORCEMENT AND INTELLECTUAL PROPERTY RIGHTS: PROMOTING INNOVATION AND COMPETITION (2007). For further discussion, see 2 HERBERT HOVENKAMP ET AL., IP AND ANTITRUST: AN ANALYSIS OF ANTITRUST PRINCIPLES APPLIED TO INTELLECTUAL PROPERTY LAW §34.4 (2d ed. 2014).

no licenses to nonmembers and therefore generated no licensing income. The members may still enjoy a positive net gain by blocking third parties' access to the pooled technology and, as a result, entry into the relevant market. By contrast, the administrator would enjoy no revenue source at all and would decline to participate. As a result, the administrator generally has a rational incentive to expand the licensee base from which it draws a royalty stream, which demands that royalty rates be set at some positive but not especially burdensome level.[53]

c. Economies of Scale

Using a third-party administrator will tend to increase both the number of patentees that can be made members in the pool and the number of licensees to whom access to the pool can be given. Without a third-party administrator, no individual member would be willing to undertake these costs (absent a sufficient side payment), resulting in a small pool with a limited number of licensors and licensees. A stand-alone administrator can bear those costs more easily for three reasons: (1) subject to payment of an administrative fee, it is not subject to free-riding effects that discourage any individual member from bearing those costs; (2) as a repeat player in the business of managing and enforcing IP rights, it enjoys economies of scale and learning in licensing and enforcement activities; and (3) having a competitive long-term stake in the pool-administration market, it has a reduced incentive to manipulate auditing procedures in the royalty-collection and allocation process.

II. PATENT NETWORKS IN ICT MARKETS

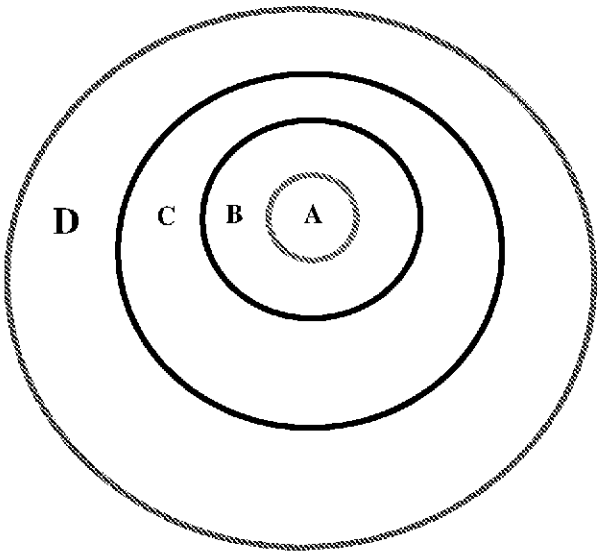
A. Background

Market practice involving patents in the ICT industry flies in the face of widely expressed views that patents generate transactional bottlenecks that result in depressed innovation. Contrary to the standard narrative that envisions an entangled web of conflicting patent claims, significant segments of real-world ICT markets consist of highly structured relationships that use contractual arrangements to mediate the transmission of IP assets from the holders to the users of those assets. In this Part, patent-mediated relationships in ICT markets are more closely examined. In particular, I show how patent pools support transactional clusters that connect a small number of leading

53. The history of the formation of a patent pool in the sewing machine market illustrates this divergence of interest between operational firms and a stand-alone patent holder. To resolve patent infringement litigation, the four leading firms in the industry formed the Sewing Machine Combination together with the individual holder of a pioneering patent. At the insistence of the pioneer patentee, the pool committed to license to at least twenty-four licensees, precisely because the pioneer sought to maximize his licensing income by creating a large licensee base. *See* RUTH BRANDON, A CAPITALIST ROMANCE: SINGER AND THE SEWING MACHINE 98 (1977). For the leading discussions of the sewing machine patent pool, see Adam Mossoff, *The Rise and Fall of the First American Patent Thicket: The Sewing Machine War of the 1850s*, 53 ARIZ. L. REV. 165 (2011); Ryan L. Lampe & Petra Moser, *Do Patent Pools Encourage Innovation? Evidence from the 19th-Century Sewing Machine Industry*, (Nat'l Bureau of Econ. Research (NBER), Working Paper No. 15061, 2009), *available at* http://www.nber.org/papers/w15061.pdf.

intermediaries with a small population of high-frequency licensors, a larger population of low-frequency licensors, and an even larger population of licensees. The multiple-nested structure of pool entities is depicted crudely below, where the size of each region roughly indicates the number of entities that populate that region. Part I.B illustrates intermediary-licensor and licensor-licensor relationships (that is, the relationships between regions A, B and C below) with greater precision through graphs generated using network visualization software.

Figure 3. The Nested Structure of Patent Pools



Legend:

A: Intermediary or consortium
B: High-frequency licensors
C: Low-frequency licensors
D: Licensees (incl. B, C, others)

B. Network Concepts and Terminology

The following discussion is an abbreviated overview of the terms and concepts required to appreciate the discussion of patent networks that follows; for more complete coverage, the reader is directed to existing reference books in the field.[54]

54. *See, e.g.*, MARK NEWMAN, NETWORKS: AN INTRODUCTION (2010).

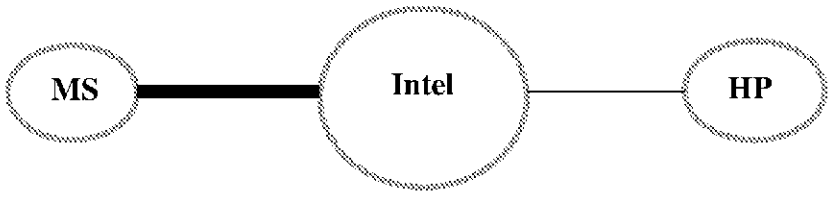
1. *Network Elements: Nodes and Edges*

Broadly speaking, networks consist of relationships among two or more entities or individuals in time or space. The systematic study of social networks identifies patterns that characterize the connections between groups of individuals or entities in a certain environment. To use the nomenclature of network science, researchers examine the characteristics of "edges" (that is, links or connections) that exist between two or more "nodes" or "vertices" (that is, points) in a certain population. The concept of a network applies to any environment consisting of multiple points of interaction among multiple individuals or entities—for example, relationships among members of boards of directors, members of a social club, or members of a legislature.

2. *Network Characteristics: Edge Weights; Node Size*

The connections between different points in a network can have different "values" or characteristics. These characteristics can reflect significant differences between what would otherwise be indistinguishable relationships among the same set of individuals or entities. The simplest type of network consists of "unweighted" or binary edges—meaning, that the network visualization solely reflects whether two or more entities or individuals (that is, "nodes") are connected. By contrast, a "weighted" edge reflects the frequency, intensity or other feature of the connections that exist between two or more nodes. For example, in the Figure 4 below, Intel may be connected to both Microsoft and HP by email communication between the firms' executives; however, the connection between Intel and Microsoft is much stronger than the connection between Intel and HP if executives at the former pair exchange emails ten times every day while executives at the latter pair exchange email once a month. Only a weighted edge (denoted by line thickness) would reflect the different intensities of these otherwise indistinguishable relationships. Now suppose further that Intel communicates both with Microsoft and HP but HP and Microsoft each communicate only with Intel and never with each other. As shown below, node size can be used to indicate that Intel is more connected—in the terminology of network graphs, it has the highest "degree centrality"—than the other two participants in the network.

Figure 4. Sample Network Graph



3. *Network Visualization*

Presented below in Figures 5, 6, and 7 are network graphs (produced using the NodeXL program[55]) that visualize relationships among the large numbers of entities that are participants in all operational patent pools in global ICT markets.[56]

a. Global Visualization (Pools)

Figure 5 is a weighted network graph that depicts the connections, and the intensity of the connections, between all patent pools and structurally equivalent industry consortia currently active in ICT markets. Any node indicates a patent pool and a link between two pools indicates that those pools contain at least one common licensor-member entity. The thickness of the link reflects the number of entities that are licensors-members in both pools. The size of the node indicates the number of other pools to which that pool is linked by common membership of at least one licensor—that is, its degree centrality. The color of each node indicates the "pool family" to which it belongs (as determined in most cases by the administrator affiliated with that pool).[57] As measured by the number of shared connections, the MPEG-LA family of pools situated near the center of the graph constitutes the most dominant set of players in the digital ecosystem. These MPEG-LA pools mostly relate to "codecs" used in the compression and transmission of audio and visual data.

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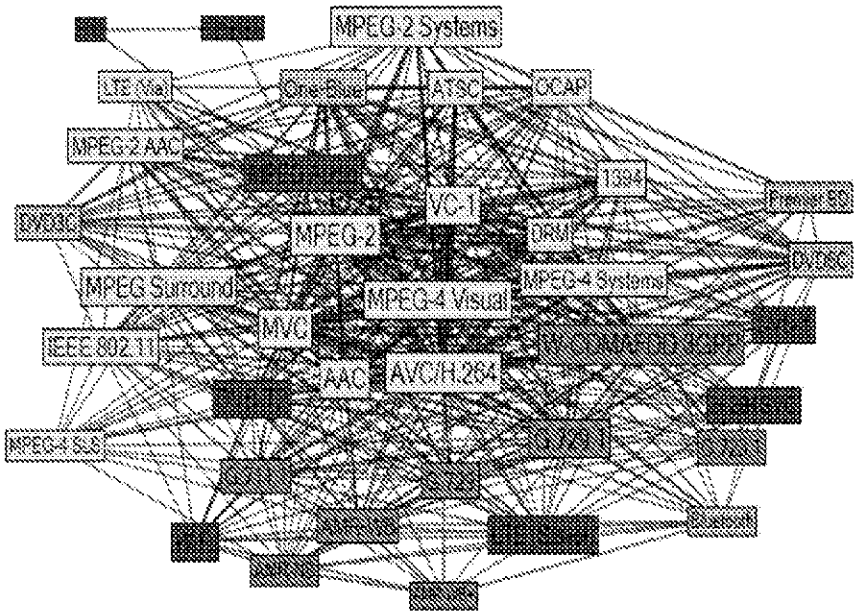
55. *NodeXL: Network Overview, Discovery and Exploration for Excel*, NODEXL.CODEPLEX.COM, http://nodexl.codeplex.com/ (last visited Sept. 30, 2014).

56. Note that this does *not* include: (1) standardization entities that lack a patent-pooling function; and (2) entities that are designated as pools by pool administrators but do not satisfy the definition of a patent pool as set forth above. *See supra* note 42.

57. Figure 5 is accompanied by a legend that identifies the color associated with each pool family. ABA Section of Science & Technology Law members may access a version of the article containing the full-color Figures at http://www.americanbar.org/groups/science_technology.html. Nonsubscribers may access a copy of the working paper containing the full-color figures via SSRN at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2431917.

Figure 5. Pools and Consortia in ICT Markets[58]



Legend: light green = MPEG LA; purple = SISVEL; light blue = Via Licensing; gray = Sipro Labs; pink = VoiceAge; orange = industry consortium

b. Global Visualization (Pool Administrators; Licensors)

Figure 6 provides an alternative visualization of pool relationships in ICT markets by displaying connections between all licensors-members and pool administrators (or consortia).[59] Individual pools have been aggregated under the relevant administrator, which identifies administrator-licensor clusters in the pool ecosystem. Each licensor is linked to every administrator that administers a pool in which that licensor is a member. Edge weight (line thickness) indicates the number of connections between a particular administrator and a particular licensor (i.e., the number of the administrator's pools in which the licensor is a member). Node size indicates degree centrality, which refers in

58. Information presented was current as of July 8, 2014. ABA Section of Science & Technology Law members may access a version of the article containing the full-color figure at http://www.americanbar.org/groups/science_technology.html. Nonsubscribers may access a copy of the working paper containing the full-color figure via SSRN at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2431917.

59. In Appendix C, I include the most complete (but most complex) visualization that includes all pools and all licensors-members and all connections between those entities.

this case to the number of other entities to which any particular entity is connected through an administrator-licensor relationship. In the case of administrators or consortia (denoted by a rectangle), color indicates the administrator's or consortium's "pool family" consistent with the color designations used in the Figure above. In the case of each licensor-member (denoted by any shape other than a rectangle), node shape indicates the member's primary market (hardware, telecommunications, technology licensing or other)[60] and node color denotes the entity's primary geographic base (East Asia, Europe or North America).[61]

Two important observations emerge from this visualization. As measured by degree centrality, the patent pool network in ICT markets is dominated by a small number of leading pools and a small number of leading licensors-entities.

(1) *Dominant Administrators*

Dominant administrators can be identified by node size, which reflects the number of connections the administrator has with licensors-members. That position is occupied by MPEG LA.

(2) *Dominant Licensors-Members*

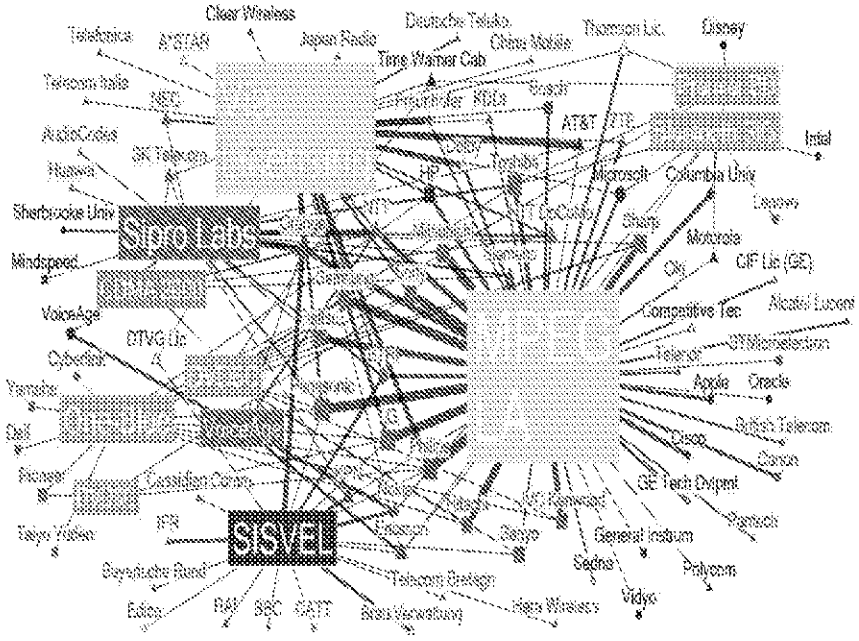
Dominant licensor-entities can be identified by: (1) node size, which reflects the number of administrators with which those entities are connected as a licensor, and (2) edge weight, which reflects the intensity of connections between a particular licensor and a particular administrator. That position is occupied by a small cluster of firms concentrated toward the center of the graph in the vicinity of the MPEG LA administrator.[62] All these entities exhibit larger node sizes (indicating higher degree centrality) relative to other licensors-members. As indicated by node shape, these influential entities are almost all large vertically integrated hardware manufacturers and are mostly based in East Asia (as indicted by node color).

60. See legend accompanying Figure 6 for the meaning of each shape.

61. See legend accompanying Figure 6 for the geographic designation behind each color.

62. The distribution of pool membership among the total pool of licensors is significantly skewed. As of July 8, 2014, out of a total of ninety-four firms that are members in at least one pool or consortium, approximately ten percent are members in ten or more pools or consortia, forty-seven percent are members in two to nine pools or consortia, and forty-four percent are members in only a single pool or consortium. Firms with ten or more pool memberships are (in declining order of number of pool memberships): Orange (17); Philips (16); Panasonic (15); LG (14); Nippon Telegraph (13); Sony (12); the Electronics and Telecommunications Research Institute (ETRI) (10); Toshiba (10); and Samsung (10). As I show subsequently, the same skewed distribution extends to the MPEG LA family of pools when examined separately.

Figure 6. ICT Pooling Clusters[63]



Legend:

Administrators: rectangle = administrator; light green = MPEG LA; light blue = Via Licensing; purple = SISVEL; pink = VoiceAge; gray = Sipro Labs; orange = industry consortium

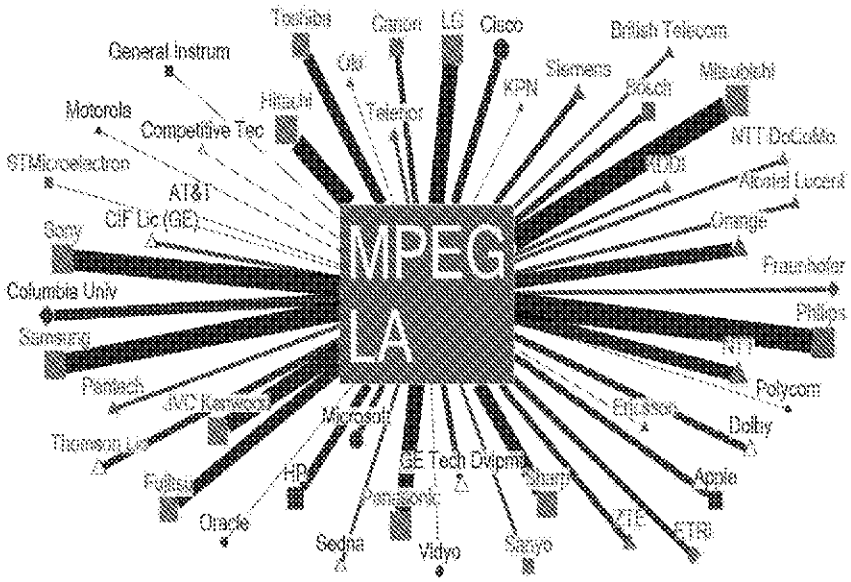
Licensors: square = hardware; circle = software; filled triangle = telecom; unfilled triangle = licensing entity; diamond = gov't/academic; green = Europe; blue = North America; red = East Asia

63. Information presented was current as of July 8, 2014. To improve readability, affiliated entities of Cisco (including Scientific Atlanta), Deutsche Telekom, Dolby, Columbia University and Philips were consolidated into a single entity under the respective parent's name. If the parent and the subsidiary were both members in the same pool (which occurred once in each case), I discarded the "extra" membership. ABA Section of Science & Technology Law members may access a version of the article containing the full-color figure at http://www.americanbar.org/groups/science_technology.html. Nonsubscribers may access a copy of the working paper containing the full-color figure via SSRN at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2431917.

c. Local Visualization: MPEG LA

Visualization can be used to focus on the characteristics of the MPEG LA pool system, the most dominant existing pool administrator. The graph below is a "hub and spoke" network that depicts the connections between the MPEG LA administrator and all licensors-entities that are members in any MPEG LA pool. Node size and edge weight now both reflect the number of MPEG LA pools in which each licensor is a member (and, in the case of MPEG LA, the number of licensors that are members in any of its pools). As indicated by those measures, we again observe approximately the same set of dominant licensor-entities, consisting primarily of integrated hardware manufacturers that (with the exception of Philips and Hewlett Packard) are mostly based in East Asia.

Figure 7. The MPEG LA Cluster[64]



Legend:

square = hardware; circle = software; filled triangle = telecom; unfilled triangle = licensing entity; diamond = government-academic; green = Europe; blue = North America; red = East Asia

64. Information presented was current as of July 8, 2014. ABA Section of Science & Technology Law members may access a version of the article containing the full-color figure at http://www.americanbar.org/groups/science_technology.html. Nonsubscribers may access a copy of the working paper containing the full-color figure via SSRN at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2431917.

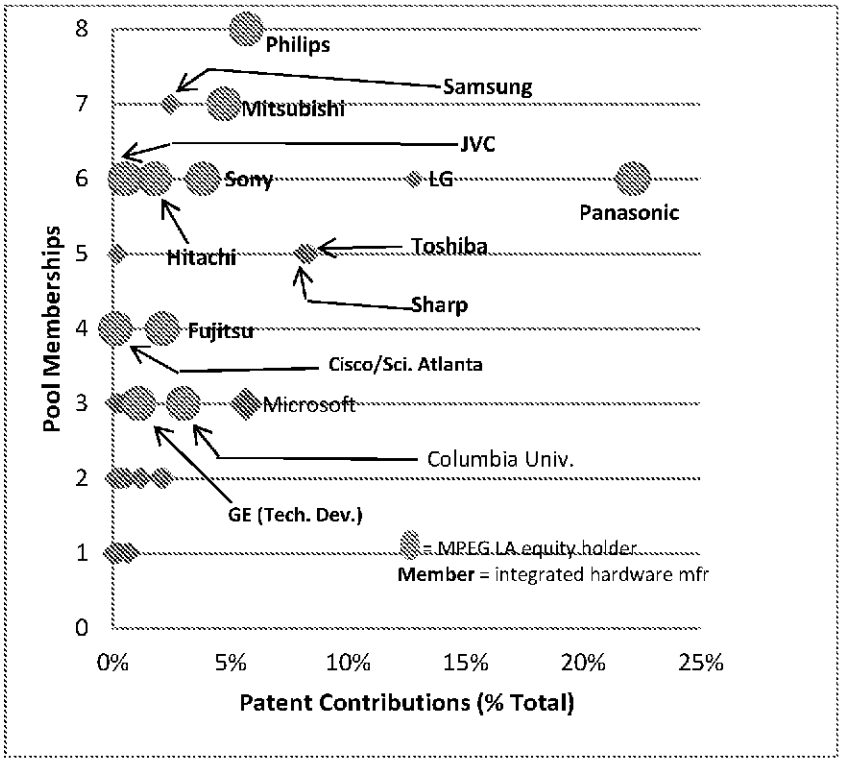
d. Other Measures of Dominance

Degree centrality, reflecting the number of pool memberships, may not be the best measure of "dominant" licensor-entities, at least if used exclusively. To address this point, we can alternatively measure dominance by each entity's estimated patent contribution, as a percentage of the total patents contributed to the MPEG LA pools, and then aggregate it with dominance as measured by the same entity's number of pool memberships. The results of using these two measures are depicted in the graph below. Subject to certain data limitations discussed below,[65] the ranking of dominant entities is largely unchanged. As shown in the Figure below, the most dominant entities taking into account both patent contributions and pool memberships consist of approximately the same set of large, vertically integrated hardware manufacturers (mostly based in East Asia) that are dominant as measured by pool memberships. Most of these dominant entities hold equity interests with full voting rights in MPEG LA LLC[66] (as indicated below by a large green circle). The sole exceptions to the convergence between these two measures of dominance are Columbia University and Microsoft, which are significant patent contributors but participate in relatively few pools. As shown below, both patent contributions and the number of pool memberships are skewed: a small number of firms are responsible for a large portion of the total patents contributed to MPEG LA pools just as a small number of firms are members in a significant number of MPEG LA pools. All other licensor-entities make relatively few patent contributions to MPEG LA pools in the aggregate and are members in a relatively small number of MPEG LA pools.

65. *See infra* note 67.

66. MPEG LA LLC has three classes of membership. I am referring to Class A members, which have full voting rights. These are: Columbia Univ., Cisco (Scientific Atlanta), Fujitsu, GE Technology Development, Mitsubishi, Panasonic, Philips and Sony. E-mail from Bill Geary, Senior Vice President, MPEG LA, to Jonathan M. Barnett (Nov. 13, 2013, 4:44 PM) (on file with author).

Figure 8. "Dominant" Patent Pool Members[67]



III. PATENT NETWORKS: CREATING VALUE BY DESTROYING VALUE

The widespread use of patent pools, coupled with the robust flow of new devices and communications services in the ICT market, casts doubt on the view that intensive patent acquisition and enforcement have depressed innovative output. But that does not mean that a state of affairs consisting of inten-

67. Figure 8 reflects (1) pool memberships as reported on the MPEG LA website as of July 8, 2014 but (2) patent contributions as reported on the MPEG LA website as of Sept. 20, 2011. The data relate to all pools currently administered by MPEG LA in the ICT market, except for the MVC patent pool that was formed in 2013. The rationale for using the earlier 2011 date to assess patent contributions is as follows. Patent contributions to the MPEG LA pools are constantly in flux and, absent aggregate data for all patent contributions over time, must be assessed as of some fixed date. The selection of any such date is inherently imperfect because it may: (1) include some patents that were previously contributed but expired, or (2) fail to include patents that were subsequently added to the portfolio. In the case of the selected MPEG LA pools, an earlier date would appear to be more reflective of each entity's total patent contribution over time because some members' prior patent contributions are not reflected in the pools' currently reported patent holdings, apparently because of the removal of patents that had expired. Hence, this data are best understood as a fairly close and the most feasible approximation of the actual total patent contributions made by each firm to the selected MPEG LA pools.

sive patent issuance coupled with patent pooling represents the most efficient feasible outcome. It might still be countered that, even if pooling arrangements reduce transactional frictions, that achievement comes at the price of imposing a collusive tax on intermediate and end users of the pooled technology, resulting in a net welfare loss relative to a market without these arrangements.[68] Part III examines this possibility with respect to the patent pools that are administered by MPEG LA in contemporary ICT markets.[69] Based on available evidence, I argue that there is little support for viewing these selected MPEG LA pools as a collusive effort to inflate the price of accessing the pooled technology. Rather, I conclude that those pooling arrangements are best understood as a collective effort to *reduce* the price for accessing the pooled technology. Licensors-members have an interest in minimizing the costs of accessing the pooled technology insofar as doing so accelerates adoption of the underlying technological standard, which in turn stimulates demand for licensors-members' goods and services that are complementary to that standard. This "commoditization effect" generates both a private gain for pool participants and a social gain for society at large, unless the price for upstream technology inputs is driven below efficient levels. Whereas the "old" pools may have generated prices for patented technology that were too high, the "new" pools may generate prices for patented technology that are too *low*.

A. Commoditization: Theory and Strategy

To understand how patent pools may reduce the price of pooled technologies, it is necessary to review the relationship between the commoditization process and innovation incentives.

1. *Commoditization and Innovation*

Commoditization refers to the process by which any particular market reaches a sufficiently competitive state of affairs such that all providers in the market are compelled to supply the relevant product at a price set equal or roughly equal to marginal cost.[70] This is simply the textbook outcome of a perfectly competitive market. From the perspective of both users and society in general, commoditization has mixed effects: (1) during the course of commoditization, users enjoy improved pricing on existing products as competitors race to preserve market share; but (2) once commoditization is complete and, so long as entry threats are absent, users suffer inflated pricing and few new products. The rationale is as follows: as a necessary result of the commoditi-

68. To be complete, this argument would have to assume that the same flow of technological innovation would still be produced under a market that operated under a weaker intellectual property system. That in turn requires some specification of an alternative means by which entities engaged in innovation and commercialization could capture returns at a lower social cost. Intellectual property discussions typically overlook the second requirement.

69. MPEG LA was selected for two reasons: (1) there is more information available about this pool family as compared to the other pool families; and (2) it is clearly the most dominant administrator among all patent pools today.

70. For a nontechnical treatment for a business audience, see RICHARD A. D'AVENI, BEATING THE COMMODITY TRAP (2010).

zation process (and assuming no regulatory and other constraints that constrain firm size), the market ultimately converges on a single monopoly provider of the relevant product. While that provider would be the most cost-efficient firm (and would continue to have incentives to improve process efficiency even further to maximize monopoly profits), the absence of competition may enable it to pocket all or some of the savings from the process efficiencies by virtue of which it had prevailed in the commoditization process.[71] Even setting aside these distributional effects, this is almost certainly an undesirable outcome. Long-term efficiency losses would ultimately swamp short-term efficiency gains: the remaining provider would have reduced incentive to invest in product innovation or maintain pricing at competitive levels. Even if some actual or potential competitive threat were expected to persist in a partially commoditized market, the shortfall in expected rents relative to a monopolistic market would still reduce innovation incentives. As a general principle (which will be qualified below), commoditization does not create a hospitable environment for innovation.

2. *Commoditization as Strategy*

It is an overstatement to say that commoditization *entirely* destroys incentives for product innovation. Most precisely, it shifts product innovation toward the next-most-profitable market opportunity, which may often be found among complementary portions of the relevant product-services bundle. For this reason, commoditization can offer a strategic tool by which a firm can shift the competitive locus toward those portions of the product-services bundle in which it has a comparative technical or other advantage. This strategy is illustrated by the evolution of the personal computer market. At the inception of the mass market for personal computers, Apple was the pioneer with its Macintosh line (released in 1977). Apple followed a closed strategy: it developed and internally manufactured most components and applications and refused to license its operating system to other manufacturers. In contrast, in 1981 IBM released the PC, a modular system for which interoperable components could be produced by third-party manufacturers, and contracted with a start-up (called Microsoft) to develop an operating system for IBM on a nonexclusive basis. As a result of these actions, IBM largely displaced the closed Apple system but commoditized the PC hardware, which ultimately compelled IBM to exit from the market it had pioneered.[72] But the PC is far from an entirely open system available to users at marginal cost; rather, commoditization of the PC hardware shifted rents to other components in the same product-services bundle to which access could be regulated—namely, the operating system and applications suite dominated by Microsoft and the microprocessor

71. The share of the cost savings that would be retained by the monopolist would depend both on competitive threats and the level of demand elasticity in the relevant market.

72. IBM was unable to use copyright to prevent "clean room" reverse engineering of the basic input-output system (BIOS) component. *See* MARK BLAXILL & RALPH ECKARDT, THE INVISIBLE EDGE: TAKING YOUR STRATEGY TO THE NEXT LEVEL USING INTELLECTUAL PROPERTY (2009).

component dominated by Intel.[73] More recently, the Linux open-source operating system (the basis for Google's Android operating system) has adopted an even more open approach by distributing its product at no charge and with few contractual constraints. However, closer scrutiny shows that this apparently altruistic policy promotes a classic commoditization objective.[74] Linux is principally supported by IBM and other large firms that seek to commoditize the operating system platform. This in turn enables those sponsors to earn rents on other portions of the products-services bundle (in IBM's case, server hardware) in which they have a competitive advantage.[75]

3. *Commoditization and Pooling*

Pooling and other multilateral patent licensing arrangements can (but will not always) result in complete or partial commoditization outcomes. Some level of commoditization will occur whenever pooling results in a lower aggregate price (including transaction costs) for accessing the pooled technologies than the price that would prevail if those technologies had been licensed by each holder individually through one-off transactions. This is most easily seen in the case of a pool such as Bluetooth SIG, an independent consortium that licenses its technology pool without a royalty obligation (but subject to certain contractual constraints[76] and, in some cases, a membership fee[77]). As a result of the Bluetooth pool, commoditization is complete: no third party would rationally pay *any* positive price for any patented technology held by a licensor-member of the pool. (Note that this is the same effect targeted by the open-source distribution of the Linux operating system, partially achieved by the cloning of PC hardware, and actually achieved in the internet browser market.) Commoditization is partial in the case of the other patent pools that populate the ICT market, all of which assess some positive royalty.

B. MPEG LA Pools: The Evidence

We can now apply theory to practice. Four pieces of evidence support an understanding of the MPEG LA pools as a partial commoditization tool: (1) the history of the formation of MPEG LA; (2) the membership of the MPEG LA pools; (3) the nonprice licensing terms demanded by MPEG LA pools; and, with less certainty, (4) the royalty rates set by the MPEG LA pools.

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73. By a recent estimate, Microsoft and Intel together represent approximately seventy-five percent of the total operating profit generated by the personal computer market. *See* Financialist Staff, *The Apple vs. Samsung Title Fight for Mobile Supremacy*, FINANCIALIST (Aug. 8, 2013), http://www.thefinancialist.com/the-apple-vs-samsung-title-fight-for-mobile-supremacy/.

74. *See* Jonathan M. Barnett, *The Host's Dilemma: Strategic Forfeiture in Platform Markets for Informational Goods*, 124 HARV. L. REV. 1861, 1930–32 (2011) [hereinafter Barnett, *The Host's Dilemma*]; Ronald J. Mann, *Commercializing Open Source Software: Do Property Rights Matter?*, 20 HARV. J. L. & TECH. 1, 23–25 (2006).

75. Barnett, *The Host's Dilemma*, *supra* note 74; Mann, *supra* note 74.

76. *See* Bluetooth Patent & Copyright License Agreement and Trademark License Agreement. *Membership Agreements*, BLUETOOTH.ORG, https://www.bluetooth.org/en-us/members/membership-agreements (last visited Oct. 19, 2014).

77. For further details on the membership fee, see *SIG Membership*, *supra* note 15.

Please note that this analysis is limited to the selected MPEG LA pools and does not necessarily generalize to other MPEG LA pools or pools administered by other entities that I have not examined closely.

1. *History*[78]

The origins of MPEG LA support the view that it was established to commoditize fundamental audio and video digital transmission technologies. Before the standardization process that produced the "MPEG-2" standard, CableLabs (a collective nonprofit R&D entity founded in 1988 by North American cable television operators) and other firms had promoted the development and standardization of video compression technology for purposes of assisting in the launch of digital television services. To do so, CableLabs and its partners (including two hardware manufacturers, General Instrument and Scientific Atlanta, which became founding members of MPEG LA pools) issued a "Request for Proposal" in 1991 for purposes of acquiring digital compression technology from an outside provider.[79] In 1993, the MPEG-1 standard, a standard for the delivery of video and audio data on compact discs and the precursor to the MPEG-2 standard for digital video compression, was agreed upon at a meeting of the Moving Picture Experts Group, a standardization body that operates under the umbrella of the International Telecommunications Union. To facilitate implementation of the standard, interested constituencies, including patent holders, manufacturers and other intermediate users (led by CableLabs), established MPEG LA as a licensing authority. The organization was initially headed by the then representative of CableLabs—that is, by a net user of video transmission technology that would have a rational interest in minimizing the royalty stream owed to upstream IP rights holders. Consistent with that view, CableLabs later assisted in formation of a patent pool relating to the Open Cable Application Platform (OCAP), at which time it advocated (unsuccessfully) for a royalty-free licensing policy.[80]

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78. Part III.B.1 is based on information set forth in CABLE TELEVISION LABORATORIES, A DECADE OF INNOVATION: THE HISTORY OF CABLE LABS 1988–1998 (1998), at 24; Press Release, CableLabs, Group to Handle MPEG Intellectual Property Issues (Apr. 25, 1994), http://web.archive.org/web/20131011053956/http://www.cablelabs.com/news/pr/1994/1994_04_25.html (accessed by searching for CableLabs Press Releases in the Internet Archive's Wayback Machine); Press Release, CableLabs, MPEG IPR Backgrounder, http://web.archive.org/web/20131011054716/http://www.cablelabs.com/news/pr/ipr_backgrounder.html (accessed by searching for CableLabs Press Releases in the Internet Archive's Wayback Machine).

79. *See* CABLE TELEVISION LABORATORIES, *supra* note 78, at 39. General Instruments was subsequently acquired by Motorola and became part of Motorola Mobility, which was acquired by Google in May 2012. *See* Press Release, Google, Google Inc. Announces Second Quarter 2012 Financial Results (July 19, 2012), *available at* http://investor.google.com/pdf/2012Q2_google_earnings.pdf; Joseph N. DiStefano, *Google Buys Horsham Plant in $12.5B Motorola Deal*, PHILLY.COM (Aug. 15, 2011), http://www.philly.com/philly/blogs/inq-phillydeals/Google-buys-Horsham-plant-in-Motorola-Android-deal.html.

80. Jeff Baumgartner, *CableLabs, DVB to Form OCAP Licensing House*, CED MAGAZINE, (May 7, 2003, 8:00 PM), http://www.cedmagazine.com/news/2003/05/cablelabs,-dvb-to-form-ocap-licensing-house.

2. *Pool Membership and Nonmembership*

Vertically integrated hardware manufacturers dominate patent pools in general and the MPEG LA family of pools in particular. As of 2014, four of the most dominant firms in the MPEG LA ecosystem—Samsung, LG, Sony and Panasonic—accounted for an estimated 53.7% of global revenues in the consumer electronics market.[81] Individually none of these entities holds a patent portfolio that covers the hundreds to thousands of components required to manufacture a given hardware item—for example, a DVD player, Blu-ray disc player, laptop or smartphone device. As is the case with respect to any required input, these firms rationally seek to minimize the cost paid for the technological components required to manufacture that hardware. Collectively bargaining for technological inputs through a patent pool has two possible virtues: (1) it increases the manufacturer's margins on the services it provides to the end user market or (2) to the extent compelled by competitive pressures, it improves the manufacturer's ability to compete by reducing the price charged in the end user market.[82] This explains both why hardware manufacturers dominate the membership of the MPEG LA patent pools and why certain other types of entities are usually *not* members of the MPEG LA pools or other patent pools in ICT markets. These nonparticipants tend to be upstream suppliers of technological inputs that hold high-value patent positions, exhibit high R&D intensities (R&D investment as a share of firm sales revenues), lack robust downstream production capacities, and derive revenues primarily by licensing patented technology to downstream manufacturers and other intermediate users.

These differences in pooling preferences derive logically from differences in industrial organization, which translate into different points of comparative advantage along the market supply chain. This proposition can be illustrated by recent efforts (largely unsuccessful) to establish patent pools in the wireless 3G and 4G telecommunications markets. Qualcomm is a large semiconductor firm that holds the most fundamental patents in CDMA-based[83] wireless tele-

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81. IBISWORLD, GLOBAL CONSUMER ELECTRONICS MANUFACTURING 23 (2014).

82. Other authors have observed that pools can operate as monopsonies that artificially depress the price of the licensed technology. *See* HOVENKAMP ET AL., *supra* note 52, § 35.6b; J. Gregory Sidak, *Patent Holdup and Oligopsonistic Collusion in Standard-Setting Organizations,* 5 J. COMP. L. & ECON. 123, 143–146, 149–151 (2009). For related discussions of monopsonistic concerns in the standard-setting process, see Damien Geradin & Miguel Rato, *Can Standard-Setting Lead to Exploitative Abuse? A Dissonant View on Patent Hold-Up, Royalty Stacking and the Meaning of FRAND,* 3 EUR. COMPETITION J. 101 (2007); Richard Schmalensee, *Standard-Setting, Innovation Specialists and Competition Policy,* 57 J. INDUS. ECON. 526 (2009). In the business letter that preliminarily approved formation of the 3G Patent Platform, the Department of Justice recognized the possibility that the platform (which consisted of a complex multipool structure) could have monopsonistic effects. *See* Letter from Charles A. James to Ky P. Ewing, *supra* note 40.

83. CDMA refers to code-division multiple access technology for cellular telecommunications. It was pioneered by Qualcomm and is the leading alternative to time-division multiple access (TDMA) technologies for wireless communications that are most often used in GSM cellular systems. *See* DAVE MOCK, THE QUALCOMM EQUATION: HOW A FLEDGLING TELECOM COMPANY FORGED A NEW PATH TO BIG PROFITS AND MARKET DOMINANCE, at xiv, 2 (2005).

communications[84] but does not participate in any existing patent pool. To the contrary: its annual report characterizes efforts to establish patent pools in wireless telecommunications as a collective attempt by wireless operators and "other like-minded companies and other organizations" to use standard-setting mechanisms to set a maximum aggregate royalty rate.[85] Unlike the vertically integrated firms that dominate the MPEG LA ecosystem (or the handset manufacturers in the wireless telecommunications segment), Qualcomm uses a "fabless" model that outsources chip production to third-party foundries and derives a large portion of its revenues from downstream licensing,[86] which it then reinvests (in part) in its R&D operations, thereby expanding the patent portfolio from which it can draw licensing revenue. Illustrative of this focus on upstream R&D, Qualcomm has a significantly higher R&D intensity (R&D expenditures as a percentage of sales revenues), twenty percent, compared to the dominant firms in the MPEG LA ecosystem, which tend to exhibit R&D intensities in the range of five to six percent.[87] For Qualcomm and other nonintegrated technology firms, participation in a patent pool threatens to generate commoditization effects that reduce the licensing revenue that an upstream supplier can extract from downstream manufacturers and other intermediate users.

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84. *See* Maisie Ramsay, *Report: Qualcomm Has Lead with 4G Patents*, WIRELESS WEEK (Nov. 16, 2009), http://www.wirelessweek.com/news/2009/11/report-qualcomm-has-lead-4g-patents. Qualcomm holds 24% of the patents declared as "essential" to the LTE or 4G wireless telecommunications standard. According to one industry estimate, Qualcomm holds 5.65% of all patents relating to the 4G-LTE standard and 12.46% of the strongest patents. The other leading patentee in this technology area is Samsung (9.36% and 12.15% respectively). *See* IRUNWAY, PATENT AND LANDSCAPE ANALYSIS OF 4G-LTE TECHNOLOGY 1, 9 (2012) Qualcomm's suspicions are well founded. *See* Press Release, Wireless Indus. Leaders Commit to Framework for LTE Tech. IPR Licensing, ERICSSON.COM (Apr. 14, 2008), http://www.ericsson.com/news/1209031 (committed to by Ericsson, Alcatel-Lucent, NEC Corp., NextWave Wireless, Nokia, Nokia Siemens Networks, and Sony Ericsson) (announcing agreement that aggregate royalties for handsets implementing the 3G/4G LTE standard should be capped below 10% of handset prices). *See also* Tobias Buck, *Groups Push for Action on Intellectual Property*, FINANCIAL TIMES (Nov. 21, 2005, 10:12PM), http://www.ft.com/cms/s/2/9609cb48-5ab1-11da-8628-0000779e2340.html#axzz3D8l3yTM9 (reporting that group of mobile carriers had made proposals at standard-setting organization that terms of patent licenses should be agreed upon before the standard was established and that maximum royalty payment to individual patentees should be capped).

85. QUALCOMM INC./DE: FORM 10-K (ANNUAL REPORT) 16 (2012), *available at* http://files.shareholder.com/downloads/QCOM/3466685375x0x618820/33BFFD14-191D-4081-A6F2-494D546F67CA/2012_form-10-K.pdf.

86. *Id.* at 6–7.

87. R&D intensities for those other firms are as follows: Panasonic (6.6%); Sony (6.7%); Cisco (11.9%); Hitachi (4.3%); Samsung (6.2%); HP (2.6%); Fujitsu (5.3%), Philips (7.8%), Mitsubishi (4.3%), Sharp (6.3%), JVC Kenwood (6.4%), Canon (8.7%), Toshiba (5.2%). EUROPEAN COMM'N, EU R&D SCORECARD: THE 2012 EU INDUSTRIAL R&D INVESTMENT SCORECARD 83–124 (2013).

3. *Licensing Terms (Nonprice)*

With some case-specific variation, the MPEG LA pools all offer licensees approximately the same nonprice terms (by which I mean all terms other than the royalty rate).[88] While certainly influenced by antitrust risk, these terms tend to be protective of licensees, which is consistent with the argument that the pools are designed by intermediate users to favorably influence the price and other terms for accessing outside technology.

a. Nondiscrimination

MPEG LA operates under a nondiscrimination policy that treats licensors and licensees equally with respect to the royalty and other license terms.[89] This has a critical implication: it means that a licensor must pay for use of the pooled technology on the same terms as a licensee.[90] Hence, any royalty or contractual constraints included in the pool's licensing terms—and any increase in that combined monetary and nonmonetary burden—will be borne by any licensor who seeks to access the pooled technology. All licensors in the MPEG LA pools can be expected to simultaneously act as licensees, with the exception of pure technology suppliers such as research institutions (for example, Columbia University and the Fraunhofer Society), and therefore do not have an unqualified interest in increasing the royalty rate. To illustrate, consider Panasonic: for fiscal year 2011–2012, it earned $4.8 billion in sales on LCD televisions, $3.5 billion on plasma televisions, $1.8 billion on digital cameras, and $1.4 billion on Blu-ray players.[91] Given the large base of sales revenue over which MPEG LA can potentially assess its royalty, Panasonic almost certainly has a strong interest in minimizing that royalty.

b. Royalty Cap; Rate Protection

MPEG LA licensees are often protected by a royalty cap, and in the case of all pools but one, a limitation on increases in royalty rates at each renewal period. The latter provision reduces a licensee's hold-up risk by contractually limiting the administrator's ability to increase the royalty once a licensee has made a specific investment in the standard embodied by the pooled patents.

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88. For a full list of these and other terms that govern MPEG LA pools, see *infra* Appendix B.

89. Telephone interview with Bill Geary, Vice Pres., Business Development, MPEG LA (Nov. 14, 2013). At least with respect to the MPEG-2 patent pool, the MPEG LA administrator is contractually barred from offering any individual licensee terms that are "materially different" from the standard form of the MPEG-2 Patent Portfolio License. *See, e.g.*, Licensing Administration Agreement by and among MPEG LA, L.L.C. & The Trustees of Columbia U., et al. § 3.2(b)–(c) (1996).

90. By contrast, in the DVD patent pools, "there are situations where pool members have a license to pooled technology at zero royalty, or at some royalty less than that charged under the pool licenses to independent licensees." *See* M. Howard Morse, *Cross-Licensing and Patent Pools: Legal Framework and Practical Issues*, ANTITRUST & INTELL. PROP. (A.B.A. Sec. Antitrust L., Chicago, Ill.), Spring 2002, at 42, 50.

91. IBISWORLD, GLOBAL CONSUMER ELECTRONICS MANUFACTURING, *supra* note 81, at 23–27.

c. Grant-Back

All MPEG LA pool licensors and licensees are required to grant other licensors and licensees a reciprocal license on RAND terms to any patents deemed "essential" to the pool's standard.[92] This provides licensees with some protection against hold-up risk as a result of any patents held by existing licensors on future uses or extensions of the pooled technology. This protective function was illustrated in a recent litigation between Microsoft and Google, as the parent of newly acquired Motorola Mobility, a licensee to MPEG LA's AVC/H.264 patent pool. Google claimed billions of dollars in back royalties with respect to Motorola patents relating to the H.264 standard. Microsoft argued that it enjoyed a reciprocal license on RAND terms from Google. Microsoft's argument rested on the grant-back clause in the license agreement for the AVC/H.264 patent pool,[93] to which Microsoft had contributed as a licensor. Microsoft argued that it enjoyed a reciprocal license from Google on RAND terms (which imply a far lower "reasonable" royalty rate). Microsoft's argument rested in part on the grant-back clause in the license agreement for the H.264 patent pool, to which Microsoft had contributed as a licensor. Microsoft argued that Google, as a licensee to the pool (through its newly acquired subsidiary, Motorola Mobility), was obligated by the pool license to grant a RAND license to any pool licensor with respect to any future "essential patents" relating to the H.264 standard.[94] While the court ultimately adopted the RAND standard on other grounds,[95] the judge used that standard to set reasonable royalty rates that drastically reduced Microsoft's maximal royalty exposure well below the $4 billion Google had initially claimed.[96]

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92. *See, e.g.*, 1394 Patent Portfolio License §§ 7.3, 7.4, (Sep. 1, 2009) (received by e-mailing MPEG LA at licensepacket@mpegla.com); MPEG-2 Patent Portfolio License §§ 7.3, 7.4, (July 1, 2009); Agreement Among Licensors § 2.3 (July 1, 1997) (received by e-mailing MPEG LA at licensepacket@mpegla.com); Multimedia Patent Trust v. Microsoft Corp., 525 F. Supp. 2d 1200, 1209 (S.D. Cal. 2007) (discussing clause §§ 2.3 in the Agreement Among Licensors).

93. The provision requires that a licensee grant to any licensor a license with respect to any "essential" patents held by the licensor and its affiliates relating to the standard. The license must be granted on RAND terms, which are "presumed" to be equivalent to the same per-patent share of royalties to which the licensor is entitled under the pool. AVC Patent Portfolio License § 8.3 (Dec. 6, 2011) (received by e-mailing MPEG LA at licensepacket@mpegla.com).

94. *See* Plaintiff Microsoft Corp.'s Post-Trial Brief Concerning Google's AVC Patent Portfolio License at 9, Microsoft Corp. v. Motorola, Inc., 963 F. Supp. 2d 1176 (W.D. Wash. 2013) (No. C10-1823-JLR); Letter from Arthur Harrigan, Jr., on behalf of Microsoft Corp., to Judge James L. Robart, Re: *Microsoft Corp. v. Motorola, Inc., et al.*, Case No. C10-1823-JLR (Mar. 1, 2013).

95. *See* Findings of Fact and Conclusions of Law at 5, Microsoft Corp. v. Motorola, Inc. et al., 963 F. Supp. 2d 1176 (W.D. Wash. Apr. 25, 2013) (No. C10-1823JLR) (No. 681), *available at* http:// www.scribd.com/doc/138032128/13-04-25-Microsoft-Motorola-FRAND-Rate-Determination (viewing Motorola as being subject to a RAND licensing commitment arising out of commitments made to certain standard-setting organizations).

96. The district court judge set various reasonable royalty rate ranges for Motorola's patents with respect to certain Microsoft products. *See id.* at 8. Those ranges implied a total fee of about $1.8 million annually. Ultimately, a jury verdict, based on the judge's royalty calculation methodology, awarded $14.5 million in total damages. *See* David McAfee, *Nokia Tells 9th Cir. RAND Ruling Shouldn't Be Adopted*, LAW360 (Sept. 24, 2014, 7:05 PM), http://www.law360.com/articles/580792/nokia-tells-9th-circ-rand-ruling-shouldn-t-be-adopted.

d. Limited Withdrawal Rights

Licensors to the MPEG-2 pool are free to withdraw at any time, upon 30 days' notice to the pool administrator.[97] Left unqualified, this right would expose licensees to hold-up risk. Any licensor could wait until the pool is sufficiently established, then withdraw and, using the threat of an infringement suit, extract payments from licensees who had made investments specific to the technology standard covered by the formerly pooled patent. To address this risk, the agreement governing licensors to the MPEG-2 pool provides that, even if a member withdraws from an MPEG-2 pool, all existing licensees are permitted to make use of the patents that had been contributed by the member to the pool. Additionally, the terminating licensor is still subject to a grant-back obligation going forward.[98]

4. *Royalty Rates*

It now remains to consider whether the royalty rates assessed by the MPEG LA pools are consistent with the commoditization account.

a. Why Are There Any Positive Royalty Rates?

It might be objected that the positive royalty rates assessed by the MPEG LA pools (and all other pools in ICT markets with the exception of the Bluetooth pool), as well as the enforcement actions undertaken by MPEG LA and its licensors, are inconsistent with the view that these pools are designed to achieve commoditization effects. This can be easily explained. First, so long as an entity is a technology supplier to some extent, then it may maximize its net revenues by assessing some positive royalty for use of the pooled technology but limiting that royalty given that it is also a *user* of other members' technology. Second, it may be the case that some holders of critical patents in the relevant market are "net" technology suppliers located at the top of the market value chain and therefore have an interest in increasing the royalty rate. Even if net technology users predominate among members of the patent pool, those firms agree to a positive royalty to elicit participation by net technology suppliers, thereby expanding the reach of the pool, reducing hold-up risk and furthering adoption of the underlying technology as the dominant standard. A zero-royalty patent pool would violate the rationality constraint for any net technology supplier (as well as the pool administrator if it is being compensated on a percentage basis[99]).[100] Hence, even net technology users agree to a

97. Agreement Among Licensors § 7.2, (July 1, 1997) (received by e-mailing MPEG LA at licensepacket@mpegla.com).

98. *Id.* at § 7.2.1.

99. For the MPEG 2 pool, MEPG LA is entitled to a fee equal to 10% of the collected royalties up to $75 million; beyond that point, the percentage falls (5% for royalties between $75 and $250 million, and 2.5% for royalties above $250 million). Licensing Administrator Agreement § 6.1, (1996) (received by e-mailing MPEG LA at licensepacket@mpegla.com).

100. For related views, see Ray Alderman, *Disintermediation of the Standard's Value Chain, in* THE STANDARDS EDGE 41–42 (Sherrie Bolin ed., 2002). Supporting this view, some observers have noted that limitations on royalty rates have caused pools to fail because of an inability to attract some patent holders, who expect insufficient licensing income by participating in the pool.

positive royalty just up to the point where the expected gains from expanding pool coverage, reducing holdup risk and increasing the incoming royalty stream equal the increased input costs attributable to the outgoing royalty burden.

b. Are MPEG LA's Royalty Rates Excessive?

Commentators and, in some cases, antitrust litigants sometimes describe patent pools in ICT markets as disguised cartels that impose an exorbitant tax on intermediate and end users.[101] Available evidence does not support this view. Rather, that evidence tends to show that MPEG LA has little incentive to impose exorbitant royalty rates, little ability to do so, and, based on comparative data, does not actually do so.

(1) *Patent Pools Often Do Not Have Pricing Power*

Commentary on patent pools often assumes that a patent pool commands near-universal adoption in the relevant market, thereby translating into formidable pricing power.[102] This is a convenient assumption in theoretical analyses of the net welfare effects of pooling arrangements; however, it is not necessarily satisfied in practice and, even in the case of any particular pool, the precise extent of pricing power will differ throughout its life. Consider the MPEG-2 pool: since formation, it has progressively *reduced* the royalty rate (from $4 to $2.50 to $2 per device).[103] That behavior implies that MPEG LA, a well-established pool, must face constraints on its power in setting royalty terms. Consistent with that hypothesis, closer scrutiny identifies a number of factors that limit MPEG LA's ability to unilaterally set the price and nonprice terms for accessing the pools its administers.

(a) Formation Stage—Standard Not Yet Adopted

Technology markets are often, if not usually, network markets characterized by winner-take-all effects: a single dominant system prevails and, if the

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See Eric J. Iversen et al., *Emerging Coordination Mechanisms for Multi-Party IPR Holders: Linking Research with Standardization* (discussion paper for Dime Conference: Intellectual property rights for Business and Society) (preliminary draft) (2006), *available at* http://home.tm.tue.nl/rbekkers/IVERSEN%20ET%20AL_DIME_2006.pdf.

101. *See, e.g.*, Nero AG's Complaint for Violations of Section 2 of the Sherman Act, Nero AG v. MPEG LA, L.L.C., No. 10-CV-3672, (C.D. Cal. May 14, 2010) (CV-10-3672-VBF-(RZ)), 2010 WL 2131883; David A. Balto & Brendan Coffman, Editorial, *When Patents Pools Attack: Competitive Concerns from the Devolution of MPEG LA*, PATENTLYO.COM (Mar. 1, 2013), patentlyo.com/patent/2013/03/guest-editorial-on-patent-pools-and-competition.html.

102. For a similar observation that commentators typically assume that the holder of a patent essential to a technology standard always enjoys pricing power, see Geradin & Rato, *supra* note 82, at 146.

103. *See MPEG LA Reduces MPEG-2 License Royalty Rates*, DVD AND BEYOND (July 14, 2009), http://www.dvd-and-beyond.com/display-article.php?article=686. This may be because of the expiration of significant percentages of the MPEG 2 patent pool or the depressed economic fortunes of MPEG 2 licensees. It has been argued that this reduction is insufficient in light of the reduction in the cost of the electronic products that are subject to the royalty. *See* Nero AG's Complaint for Violations of Section 2 of the Sherman Act, *supra* note 101, at 4–5.

system is proprietary, its holder earns the lion's share of industry rents. As I have described elsewhere, the race to set the standard has often motivated technology firms to "give away" access to fundamental technologies.[104] Consistent with those observations, an administrator that is forming a pool for a standard that has not yet been widely adopted faces significant pressure in setting low licensing rates to promote adoption of the standard. For example, in 2012, Via Licensing, a pool administrator, announced a fee waiver for initial licensees of its newly formed pool covering patents relating to LTE (4G) wireless technologies[105] (which competes with another newly formed pool for the same technology field being assembled by Sisvel, another pool administrator).[106] So long as the pool administrator is a repeat player that seeks to maximize its total future revenue stream, this same consideration continues to exert influence even once the pool is established. This is for two reasons: (1) pool administrators are continuously seeking to attract additional licensees and thereby increase total revenues; and (2) even assuming the licensee market is saturated, an administrator that reneged on "reasonable" terms offered at the formation stage would find it difficult to launch more pools in the future.

(b) Formation Stage—Standard Already Adopted

Even if a standard has been adopted, and the pool administrator seeks to form a patent pool that tracks that standard, it still operates under pricing constraints. That is for two reasons. First, on the supply side, the pool administrator must induce participation by the holders of high-value patents that are "essential" to the standard and will be useful in inducing other potential licensees to subscribe to the pool. For the largest patent holders, independent licensing is a cost-feasible option; hence, the pool must offer significant economies of scale and a sufficiently high royalty rate to induce adoption. The difficulty of inducing adoption may lie behind the nonuniversal rate of pool participation by the holders of "essential" patents—in a group of eight pools (including pools administered by MPEG LA) in the electronics industry, it was found that participation rates ranged from 33% to 58% and "patent coverage" rates ranged from 17% to 89%.[107] Second, the administrator has incentives to

104. *See* Barnett, *Hosts's Dilemma*, *supra* note 74, at 1863.

105. *Via Licensing Announces One-Time Fee Waivers for Initial Licensees of its LTE Patent Pool*, BUSINESS WIRE (Oct. 30, 2012), http://www.businesswire.com/news/home/20121030005504/en/Licensing-Announces-One-Time-Fee-Waivers-Initial-Licensees#.VBN5MBy5Hao (announcing a fee waiver for products sold before Oct. 15, 2012, that implemented the LTE standard).

106. This is consistent with other evidence showing that SSOs adopt more "user-friendly" policies in technological segments in which other SSOs are active (as compared to segments in which there are a few or no other SSOs). *See* Chiao et al., *supra* note 18, at 906.

107. The authors determined participation rates by comparing the number of members in the pool with the number of eligible members, where eligibility is determined by reference to the firms that made patent "declarations" with respect to the corresponding technological standard. Patent coverage rates are determined by comparing the patents contributed to the pool with the total number of patents "declared" with respect to the corresponding technological standard. *See* Anne-Layne Farrar & Josh Lerner, *To Join or Not to Join: Examining Pool Participation and Rent Sharing Rules*, INT'L J. INDUS. ORG. 294, 298–99 (2011). In the case of the following MPEG LA pools, the authors found the following participation rates (out of total holders of essential patents)

reduce (or refrain from increasing) the royalty rate to attract (and retain) licensees throughout the life of the pool. Even a licensee who has made investments specific to the standard retains some leverage insofar as it can threaten the licensor with a costly litigation process, which could result in significant legal fees[108] and a disruption in any larger business relationships between the licensor and licensee.

(c) Postformation Stage

Even after a pool has been established, the administrator may continue to face pressures that discipline its behavior in setting price and nonprice terms.

[1] *Competition from Other Pools and Patentees*

Even in cases where a pool has achieved broad coverage (such as the MPEG-2 pool), the administrator's pricing freedom may still be constrained by the fact that other components of the same relevant technology are subject to patents held by other pools or entities.[109] For example, the manufacturer of a DVD player must pay a royalty to the MPEG-2 pool, the DVD6C pool, the DVD3C pool and two additional entities that license individually.[110] If the administrator wishes to promote adoption of the pooled technology and continue to elicit compliance from existing licensees, it must take into account, or take steps to influence, the pricing decisions of other patentees to avoid an overly burdensome aggregate royalty rate.[111] This explains why leading handset makers and chipset providers in telecommunications markets announce anticipated royalty rates[112] or, in some cases, strive to maintain a constant

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and coverage rates (out of total essential patents): 1394 – 53%/75%; AVC – 31%/67%; MPEG-2 – 32%/69%; and MPEG-4 – 34%/89%. *Id.*

108. The difficulties in taking legal action in response to a licensee's breach of a license contract has motivated the One-Blue pool (relating to Blu-ray player technology) to adopt a policy of per-batch licensing, in which a licensee is licensed to produce specific "batches" of products, which must be marked accordingly to facilitate the detection of licensed and unlicensed product. *See* Ruud Peters, *One-Blue: A Blueprint for Patent Pools in High-Tech,* INTELLECTUAL ASSET MGMT. (Sept.–Oct. 2011), at 38–40, *available at* http://www.one-blue.com/data/downloadables/4/5/iam-magazine_september-october-2011_article-oneblue.pdf.

109. Consider the One-Blue pool (relating to Blu-ray player technology): a licensee-manufacturer of a Blu-ray player must pay a royalty to the One-Blue pool, the competing Premier BD pool, the DVD3C and DVD6C patent pools, and several other individual licensees. *See* Den Uijl et al., *supra* note 48, at 41 fig. 3.

110. *See id.*

111. For similar views, see Geradin & Rato, *supra* note 82, at 147–48.

112. For evidence on announcements of royalty rates, see Eric Stasik, *Royalty Rates and Licensing Strategies for Essential Patents on LTE (4G) Telecommunication Standards*, LES NOUVELLES: J. LICENSING EXECUTIVE SOC'Y INT'L, Sept. 2010, at 114, 114–16, *available at* http://www.investorvillage.com/uploads/82827/files/LESI-Royalty-Rates.pdf. Relatedly, some pool administrators (for example, the One-Blue pool) commit to "pre-netting" policies, which reduce the royalty rate owed by any individual licensee if that licensee is already subject to royalty obligations with a pool member pursuant to an independent bilateral licensing agreement. Ruud Peters, *One-Blue: A Blueprint for Patent Pools in High-Tech,* INTELLECTUAL ASSET MANAGEMENT, Sept.–Oct. 2011, at 38, 40.

royalty rate over time.[113] Contrary to the simplest "prisoner's dilemma" models that do not take into account signaling possibilities, even competing patentees apparently take into account each other's pricing strategies to mitigate a collectively harmful "royalty stacking" problem.

[2] *Competition from New Pools*

A pool is always vulnerable to the formation of an entirely new standard. This risk may seem theoretical. But the history of technology markets is filled with transient monopolies that were dominant for a relatively short period but then overtaken rapidly by new alternatives.[114] The most potent threat to an existing standard is posed by entities that pursue an extreme commoditization strategy by offering an alternative standard for a zero royalty, with the intention of capturing revenues on a complementary asset. This possibility is illustrated by a recent episode involving the AVC/H.264 pool administered by MPEG LA. This pool relates to a video codec widely used in operating systems for personal computers, tablets and other computing devices and video streaming services. In an effort to displace H.264 as the standard video codec, Google launched a new standard based on the "VP8" video codec, which it made available under a zero-royalty open-source license. While MPEG LA responded by raising potential patent infringement issues (as did other patent holders who claimed infringement by the VP8 technology), which in turn sparked a short-lived antitrust investigation, it ultimately settled the dispute by granting Google a license with respect to the use of certain H.264 patents in the VP8 codec.[115] Although the terms were not disclosed, the settlement suggests that Google at least posed a credible threat of a competitive zero-royalty alternative to the H.264 standard.

(2) *Gross v. Net Royalty Rates*

The royalty rates set by each MPEG LA pool are a gross amount. But the *effective* royalty rates borne by licensors-member in the pool are a net amount calculated as the member's proportionate share of the pool's gross royalty flow *less* the gross royalty payment owing by the member to the pool. The

113. Qualcomm, the leading chipmaker in the handset market, claims to have maintained its royalty at a constant five percent of the handset's wholesale price, see Tammy Parker, *Qualcomm Focused on Bilateral Deals for LTE IPR*, TELECOMS.COM (Feb. 9, 2009), http://www.telecoms.com/4844/qualcomm-focused-on-bilateral-deals-for-lte-ipr/.

114. Consider the following: in the space of roughly fifteen years starting in the late 1990s, the portable media device market has selected and then unseated Palm as the leading device, enthroned Blackberry and unseated it, and now enjoys vigorous competition between Apple's iPhone and Android-based smartphones. For further discussion and examples, see Barnett, *Host's Dilemma, supra* note 74, at 1877–78. For similar views, see Geradin & Rato, *supra* note 82, at 149.

115. For further discussion of these events, see Ed Bott, *Google and MPEG LA Settle Long-Running VP8/H.264 Patent Dispute*, ZDNET.COM (Mar. 7, 2013), http://www.zdnet.com/google-and-mpeg-la-settle-long-running-vp8h-264-patent-dispute-7000012289/; Florian Mueller, *Setback for Google's VP8: Nokia Refuses to Commit Patents to Royalty-Free or FRAND Licensing*, FOSS PATENTS.COM (Mar. 23, 2013), http://www.fosspatents.com/2013/03/setback-for-googles-vp8-nokia-refuses.html.

royalty-allocation formula used by the MPEG LA patent pools is usually based on the number of patents a licensor contributes to the pool in each relevant jurisdiction.[116] Hence, generally speaking, the more patents a licensor contributes to the pool, the greater its licensing income that offsets licensing fees, and the lower its net royalty burden. That in turn means that the end users that purchase the devices manufactured by those firms may indirectly bear a small incremental royalty burden attributable to the pool. For the largest manufacturers, the MPEG LA patent pools may function to some extent as a cross-licensing arrangement that ensures access to the underlying technology pool, subject to a partially offsetting balance of royalty payments and a transaction fee paid to the outside administrator.

(3) *Royalty Rate Analysis*

The above two points support the view that MPEG LA would have little incentive or capacity to set "exorbitant" royalty rates, consistent with the commoditization thesis. It remains to consider whether this thesis continues to find support if we examine directly the royalty rates imposed by the MPEG LA pools, excluding for simplicity any offsetting royalty income a licensee may receive from any particular pool in its capacity as a licensor. Whether those rates reflect pricing power can only be assessed imperfectly, but the results are not inconsistent with the commoditization thesis.

For this purpose, I consider the royalty rates assessed by all the MPEG LA pools that cover codec technologies and the Firewire data transfer standard that would often if not typically be incorporated in a personal computer.[117] For illustrative purposes, I assume that (1) the licensee is Dell (which will represent a typical large branded original equipment manufacturer (OEM)) and (2) Dell is using technologies covered by the MPEG LA licenses in all of its "PC" (desktop and notebook) products. In 2012, Dell shipped an estimated 38.7 million PCs.[118] Following the terms of each relevant license (as summarized in the Table below), the total estimated aggregate royalty payable by Dell to the indicated MPEG LA pools equals approximately $102 million, which represents an estimated per-unit royalty of $2.64 (of which $2 is constituted by the

116. For example, the MPEG-2 pool license provides that, with respect to any particular product, fifty percent of the royalties are allocated proportionately to the number of patents in the country of manufacture and fifty percent proportionately to the number of patents in the country of sale. Agreement Among Licensors § 5.1.1, (July 1, 1997) (received by e-mailing MPEG LA at licensepacket@mpegla.com) (providing royalty allocation formula with respect to MPEG-2 patent pool).

117. I omit the following pools that are related to the ICT sector but not pertinent to the PC market: (1) the MPEG-2 Systems and ATSC pools (because they are designed for use in products that do not use MPEG-2 video encoders and decoders); and (2) the MPEG-4 Systems pool (because it is no longer offered).

118. *See* Press Release, IDC, *Soft PC Shipments in Fourth Quarter Lead to Annual Decline as HP Holds Onto Top Spot, According to IDC*, BUSINESS WIRE (Jan. 10, 2013, 7:13 PM), http://www.businesswire.com/news/home/20130110006397/en/Soft-PC-Shipments-Fourth-Quarter-Lead-Annual#.VBN8GRy5IIao. As defined by International Data Corporation, the term "PC" refers to desktops, laptops, notebooks and workstations, but excludes handheld devices, x86 servers and tablets.

MPEG-2 royalty). Translated into percentage terms, that amount implies an aggregate royalty rate on Dell's 2012 PC sales revenues (as reported, $33.24 billion[119]) of *.31%*, which falls well below the median reported royalty rates in the electronics and related industries (which range from 3.2% to 6.8%).[120] That result is consistent with a commoditization rationale (and, incidentally, with antitrust regulators' initial expectation that MPEG-2 royalty rates would constitute only a "tiny fraction" of end-product prices[121]). Based on this evidence, there is little support for the possibility that MPEG LA is assessing royalties that are significantly above relevant market averages for comparable technologies and even some support for the possibility that MPEG LA is assessing royalties that are significantly below those averages.

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119. According to Dell's 2012 annual report as filed on Form 10-K, it earned $14.14 billion on sales of desktop PCs and $19.1 billion on sales of notebooks and other "mobility" products, which equals $33.24 billion in total. DELL INC., Comm. File No. 0-17017, UNITED STATES SECURITIES AND EXCHANGE COMMISSION FORM 10-K (2013) at 43, *available at* http://www.sec.gov/Archives/edgar/data/826083/000082608313000005/dellfy1310k.htm#s2DE541FC6981A355F031B2561CB65605.

120. *See* Robert Goldscheider et al., *Use of the Twenty-Five Percent Rule in Valuing Intellectual Property*, *in* ROYALTY RATES FOR LICENSING INTELLECTUAL PROP. 31, 47 Ex. 3.3 (Russell L. Parr ed., 2007) (based on Royalty Source data, reporting royalties for the late 1980s–2000s as follows: electronics (4%), telecom (4.7%); semiconductors (3.2%); computers (4%) and software (6.8%)). *See also Industry Royalty Rate Data Summary*, LICENSING ECON. REV., Dec. 2007, at 6, 6 tbl.1 (Dec. 2007) (reporting average royalty rates as of 2007 as follows: telecom (5.5%), semiconductors (5.1%), computers (5.3%)). Royalty rates for 2004–2006 are similar: approximately 4% for electronics and semiconductors and 5% for computers. *See Industry Royalty Rate Data Summary*, LICENSING ECON. REV., Dec. 2006, at 2, 7 fig.1. Other sources report similar average royalty rates. *See* BOB HELD & JOEL PARKER, ROYALTY RATE AND DEAL TERMS SURVEY, LICENSING EXECUTIVES SOC'Y (Oct. 2011), http://www.lesusacanada.org/docs/surveys/2011_lits_royaltyratesurveyexecutivesummary.pdf?sfvrsn=2 (reporting average royalty rate for IT equipment and device and consumer products of 5.5%, based on responses from 52 companies, with total of 228 deals completed in 2008–2011). A 1996 publication reported an average royalty rate of 5.1% based on a sample of 95 license agreements involving telecommunications, semiconductor and computer technologies. *See* Russell L. Parr, *Advanced Royalty Rate Determination Methods*, *in* TECHNOLOGY LICENSING: CORPORATE STRATEGIES FOR MAXIMIZING VALUE 213–14 (Russell L. Parr & Suzanne P. Sullivan eds., 1996). All these estimates must be discounted by the fact that evidence on comparable industry royalty rates has certain limitations because of (among other issues) the high variance in the economic values of individual patents. *See* Roy J. Epstein & Paul Malherbe, *Reasonable Royalty Patent Infringement Damages After* Uniloc, 39 AIPLA Q.J. 3, 8–10 (2011).

121. *See* Letter from Joel I. Klein to Gerrard R. Beeney, *supra* note 40, at 11.

Table 4: Estimated Implied Royalties to MPEG LA Pools for Large OEM in PC Market (2012 Data)[122]

Pool	License Rate	Annual Royalty Cap	Implied Rate on PC Sales Revenue
AVC/H.264	$.10 to $.20/unit[123]	$6.5M	.013%
VC-1	Same	$5M	.013%
MPEG-4 Visual	Same	$2.5M	.008% (*cap applies*)
MVC	$.10/unit	$6.5M	.012%
MPEG2	$2/unit[124]	None	.233%
1394 (Firewire)	$.25/unit	None	.029%
TOTAL			.307%

C. Is Commoditization Always a Good Thing?

Following the commoditization thesis, intermediate users sometimes establish patent pools to reduce the royalty that must be paid to access upstream technology inputs. In that scenario, the pool yields both a reduction in licensing costs and transaction costs. If competitive conditions prevail in the downstream segment to which competition is shifted as a result of the pool (a likely possibility in the electronics industry, which exhibits low profit margins[125]), then those input-cost and transaction-cost savings are certainly passed on to consumers. Even if competitive conditions do not prevail in the downstream market, then that same efficiency gain remains, although it may be primarily or entirely retained by the intermediate user.[126] There is one caveat, however, to this mostly happy interpretation of the welfare effects of pooling arrangements. Namely: licensee-driven pooling arrangements can be too successful from a social point of view. If pooling pushes down the price of technological inputs to marginal cost, then downstream manufacturer-licensees minimize input costs but upstream R&D suppliers are unable to recover the

122. All information on royalty caps and royalty rates for each pool are found in the license agreements for each pool as well as the summary of license terms found on the MPEG LA website. For a summary, see *infra* Appendix B.

123. For a personal computing product, the licensee's annual royalty rate schedule is as follows: (1) for the first 100,000 units, no royalty; (2) $.20/unit for each additional unit; and (3) $.1/unit for every unit above five million units. *See Summary of AVC/H.264 License Terms*, MPEG LA, http://www.mpegla.com/main/programs/avc/Documents/AVC_TermsSummary.pdf (last visited Oct. 3, 2014). *See also* MPEG LA, *AVC Patent Portfolio License*, http://static.fsf.org/nosvn/h264-patent-license.pdf (last visited Oct. 3, 2014).

124. This assumes a device that has both MPEG-2 decoding and encoding functions, which triggers the royalty applicable to "Consumer Products." *See* MPEG 2 Patent Portfolio License §§ 1.4 (definition of "Consumer Product"); 3.1.3 (royalty payable on sales of "Consumer Product").

125. IBISWORLD, GLOBAL COMPUTER HARDWARE MANUFACTURING, *supra* note 10, at 4–6.

126. Even if competitive conditions are weak, some efficiency gains may still be rationally shared with end users depending on the level of demand elasticity in the relevant market.

fixed costs of innovative activities;[127] and, absent some other funding source, a long-term efficiency loss would result in the form of reduced R&D.[128] While intermediate users (and, subject to competitive conditions) end users are better off in the short term, they are worse off (and potentially *far* worse off[129]) in the long term.

The risk of this monopsonistic outcome would appear to be limited in the case of markets populated by the highest-value technology suppliers. Any technology supplier always has the option to elect not to participate in a pool that does not appropriately compensate the supplier for its technological contribution. For lower-value suppliers, this may not be a meaningful option because failing to participate in the pool may mean being dropped from the relevant standard (or, even if that is not the case, may require the supplier to bear infeasible licensing and enforcement costs). Higher-value suppliers, however, may control a critical component without which the standard cannot be implemented and therefore can counter the bargaining power exerted by net technology users. This is illustrated by Qualcomm's consistent refusal to participate in patent pooling arrangements organized largely by its target licensees, handset makers and telecommunications carriers.[130] Qualcomm supplies chips that are critical inputs for handset manufacturers in CDMA wireless systems and is therefore able to capture a significant royalty stream through independent licensing transactions. The failure of all three leading pool administrators to establish widely adopted patent pools in the 3G and 4G telecommunications market can be attributed in part to the competitive pressure exerted by high-value patent holders such as Qualcomm that maintain independent licensing channels. Whether that is an efficient outcome is ultimately a function of the "social quality" of the underlying patent portfolio. Assuming

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127. Other commentators have explored the related scenario in which a vertically integrated firm strategically offers below-market royalty rates to embed its technology in a standard and thereby exclude upstream stand-alone innovators from the market. *See* Geradin & Rato, *supra* note 82, at 133–34; Schmalensee, *supra* note 82, at 544–46.

128. This type of claim was brought against a nonprofit technology consortium (controlled by leading software and hardware firms), which allegedly acted collectively to reduce the price of certain software below competitive levels. The court declined to grant summary judgment with respect to some of the plaintiff's claims, although the defendant ultimately prevailed. *See* Addamax Corp. v. Open Software Found., Inc., 888 F. Supp. 274 (D. Mass. 1995); Addamax Corp. v. Open Software Found., 964 F. Supp. 549 (D. Mass. 1997), *aff'd* 152 F.3d 48 (1st Cir. 1998) (finding that plaintiff's damages did not constitute antitrust injuries). A similar claim was argued in other litigation to the effect that members of a standard-setting organization had conspired to collectively reduce the price they would pay for a certain technology input. *See* Sony Elecs., Inc. v. Soundview Techs., Inc., 157 F. Supp. 2d 180 (D. Conn. 2001) (denying motion to dismiss). For further discussion of these cases, see David A. Balto, *Standard Setting in the 21st Century Network Economy*, 18 COMPUTER & INTERNET LAWYER 5 (2001); Robert A. Skitol, *Concerted Buying Power: Its Potential for Addressing the Patent Holdup Problem in Standard Setting*, 72 ANTITRUST L. J. 727, 736–37 (2005).

129. The reason why was identified by Frank Easterbook, who pointed out that even a small decline in long-term welfare attributable to reduced innovation would swamp any short-term efficiency gains attributable to reduced prices. *See* Frank Easterbrook, *Ignorance and Antitrust, in* ANTITRUST, INNOVATION AND COMPETITIVENESS 122–23 (Thomas M. Jorde & David J. Teece eds., 1992).

130. *See* Schmalensee, *supra* note 82, at 537–40, 543–47.

the scope of the patents held by upstream suppliers is appropriately calibrated from a social point of view, it is possible that successful formation of a patent pool may reduce payments to upstream R&D suppliers below long-term efficient levels. Alternatively, if the scope of those upstream patents is too large from a social point of view, then successful formation of a patent pool would reduce input prices and prevent patent holders from increasing royalty fees extracted from downstream users above long-term efficient levels.

Scholars and policy makers often assert that the intensive acquisition and enforcement of patents stifles innovation within a web of transaction, negotiation and litigation costs. In the ICT markets, this assertion is difficult to reconcile with continuous growth in R&D investment and continuous declines in end-user prices. This article shows how ICT markets have avoided patent deadlock and any associated adverse effects on innovation by devising structures that ameliorate the transaction-cost burden inherent to a robust regime of intellectual property rights. The end result is an intricate network of patent pooling and cross-licensing arrangements that lie behind the continuous flow of new products and services in global ICT markets. At least with respect to the selected patent pools that I examine most closely, it appears that these arrangements avoid efficiency losses by precluding transactional deadlock and may even generate efficiency gains by reducing the price of accessing the technological inputs that propel the innovation and commercialization process. Those cost savings may flow to consumers in the form of reduced prices and expanded output. The private gains enjoyed by intermediate and end users translate into social gains to the extent that patent pooling sets prices for technological inputs that are sufficiently high to sustain investment by upstream technology suppliers. Otherwise those private gains would surprisingly translate into social losses in the form of reduced innovation. The primary social risk of some patent pools is not that prices are too high; rather, the prices being paid for technological innovation may be too low.

Appendix A. Patent Pooling and Similar Arrangements in ICT Markets (1995–Present)[131]

Year Est.	Standard (use)	No. Patentees-Members	No. Licensees	Pool Administrator-Consortium
1995	G.723.1 (speech codec)	3	n/a	Sipro Lab Telecom
1997	AAC (audio codec)	11	775	Via Licensing
1997	MPEG-2 standard (video codec)	27	1387	MPEG-LA
1997	WSS (widescreen signaling)	2	120	SISVEL
1997	TOPTeletext	2	120	SISVEL
1998	DVD disc/player	4	551[132]	DVD3C Consortium
1998	Bluetooth	7	>20,000	Consortium (One-Blue)
1998	G.729 (audio codec)	3	>230	Sipro Lab Telecom
1999	DVD disc/player	9	467[133]	DVD 6C Consortium
1999	1394 (Firewire data transfer)	10	213	MPEG-LA

131. Unless otherwise indicated, all information is current as of July 8, 2014 and all information was collected from the pool administrator or consortium's website. N/a means the information was unavailable. To my knowledge, this list includes all patent pools organized by pool administrators relating to the ICT market and equivalent industry consortia in the ICT markets that are still currently in force and have been established since 1995. Consistent with my definition of patent pool set forth earlier (*see supra* note 42), I excluded (1) pools for which a "patent call" has been published but the pool has not yet been established or otherwise commenced operation; (2) quasi-pool equivalents that were based solely on RAND or zero-royalty contractual commitments made by members or other participants in a standardization body; (3) pools that were established but ceased operation; (4) pools that exclusively contain patents owned by the administrator; (5) pools that exclusively contain patents licensed by a single entity; and (6) pools that exclusively contain patents contributed by, and are exclusively licensed to, the same two entities. I exclude categories (4), (5) and (6) because these are structurally indistinguishable from bilateral licensing transactions. This list may be both overinclusive (to the extent some listed pools are still in operation but do not generate significant licensing revenues) and underinclusive (to the extent I have omitted pools of which I am not aware).

132. Den Uijl et al., *supra* note 48, at 37 tbl.1.

133. *See id.*

Year Est.	Standard (use)	No. Patentees-Members	No. Licensees	Pool Administrator-Consortium
1999	W-CDMA FDD 3GPP standard	13	n/a	Sipro Lab Telecom[134]
2001	MPEG-4 Visual standard (video codec)	29	699	MPEG-LA
2001	OCAP tru2way (interactive TV programs)	6		Via Licensing
2001	MPEG Audio (audio codec)	7	1223	SISVEL
2003	MPEG-4 Systems (audio/video code)[135]	8	37	MPEG-LA
2003	MPEG-2 AAC standard (Japanese digital TV)	6	769	Via Licensing
n/a	AMR-NB (Narrow Band)	4	50[136]	VoiceAge
2004	AMR-WB+ (Wide Band Plus)	3	n/a	VoiceAge
2004	AVC/H.264 (video codec)	31	1315	MPEG-LA
2005	Digital Radio Mondiale (DRM)	11	17	Via Licensing

134. Sipro was retained as the new pool administrator in 2011. *See Sipro Lab Telecom Becomes the New Licensing Administrator of the W-CDMA Patent Pool*, PR NEWSWIRE (Jan. 12, 2011), http://www.prnewswire.co.uk/news-releases/sipro-lab-telecom-becomes-the-new-licensing-administrator-of-the-w-cdma-patent-pool-156783735.html.

135. This is not offered to new licensees; however, existing licensees continue to enjoy coverage. I therefore treat this pool as still being in operation. *MPEG-4 Systems Introduction*, MPEG LA, http://www.mpegla.com/main/programs/M4S/Pages/Intro.aspx (last visited Nov. 25, 2014).

136. This is based on information on VoiceAge's archived website, which was updated as of 2007. *Essential Patents Licensees: AMR Licensees*, VOICEAGE.COM (Oct. 14, 2007), http://web.archive.org/web/20071014162355/http:// www.voiceage.com/amr_licensees.php (accessed by searching in the Internet Archive Index).

Year Est.	Standard (use)	No. Patentees-Members	No. Licensees	Pool Administrator-Entity
2005	IEEE 802.11 (ethernet networking)	5	n/a	Via Licensing
2006	MPEG-2 Systems (audio/video codec)	10	235	MPEG-LA
2007	ATSC (N. Amer. digital television)	9	133	MPEG-LA
2007	G.729.1 (speech and audio codec)	9	n/a	Sipro Lab Telecom
2007	VC-1 (video codec)	20	318	MPEG-LA
2008	DVB-T (European digital television)	3	480	SISVEL
2008	MPEG Surround (audio codec)	7	n/a	Via Licensing
2008	G.711.1 (telephony)	5	5	Sipro Lab Telecom
2009	MPEG-4 SLS	3	n/a	Via Licensing
2009	DVB-T2 (digital video broadcasting)	9	n/a	SISVEL
2010	AMR-WB/G.722.2	4[137]	n/a	VoiceAge
2010	Blu-ray disc/player	6	46[138]	Premier BD

137. Doug Mohney, *AMR-WB and Its Future in HD Voice*, WEBRTC WORLD (May 28, 2013), http://www.webrtcworld.com/topics/webrtc-world/articles/339560-amr-wb-its-future-hd-voice.htm.

138. This amount understates the number of members because some of them are undisclosed.

Year Est.	Standard (use)	No. Patentees-Members	No. Licensees	Pool Administrator-Entity
2011	Blu-ray disc/player	15	59	One-Blue
2012	MVC (video streaming)	16	37	MPEG LA
2012	LTE (4G)	7	n/a	SISVEL
2013	H.264 SVC (video codec)	3	n/a	SISVEL
2013	LTE (4G)	12	n/a	Via Licensing
2013	WiFi	5	n/a	SISVEL

Appendix B. Selected Terms of MPEG-LA Patent Pools[139]

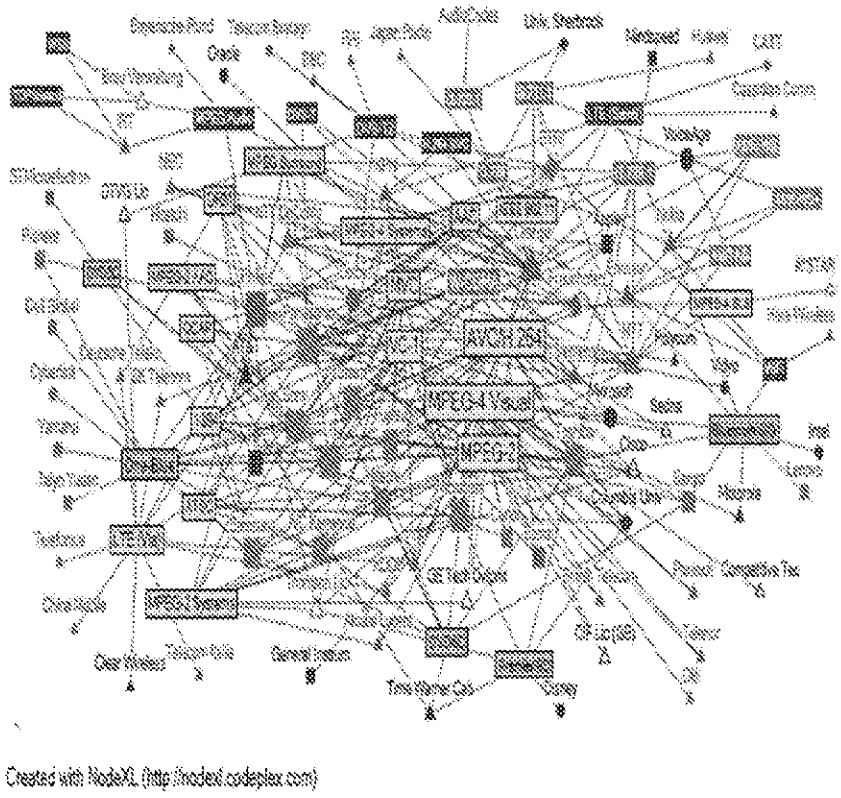
Pool	Profit-Sharing Rule[140]	End of Term	Non-Discrimination	Rate Protection at Renewal	Grant-back	Non-exclusive	RAND	Royalty Cap
MPEG-2 (video compression)	Num.; Geo.	Expiry of patents; terminable by licensee upon notice after EY2015.	Y	Y	Y	Y	Y	N
ATSC (digital television)	Num.; Geo.	EY2016. Renewable for 5-yr periods.	Y	Y	Y	Y	Y	N
AVC/H.264 (video codec)	Num.; Geo.	EY2015. Renewable for 5-yr periods.	Y	Y	Y	Y	Y	Y
VC-1 (video codec)	Num.; Geo.	EY2017. Renewable for 5 yr periods.	Y	Y	Y	Y	Y	Y
MPEG 4 Visual (video codec)	Num.; Geo.	EY2013. Renewable for 5-yr periods.	Y	Y	Y	Y	Y	Y
MPEG 2 Systems (audio/video codec)	Num.; Geo.	EY2015. Renewable for 5-yr periods.	Y	Y	Y	Y	Y	N
1394 (Firewire data transfer)	Num.; Geo.	Jan. 2015. Renewable for 5-yr periods.	Y	N	Y	Y	Y	N
MPEG-4 Systems (audio/video compression)[141]	Num.; Geo.	Valid through patent term.	Y	Y	Y	Y	Y	Y
MVC (video codec)	Num.; Geo.	EY 2016. Renewable for 5 yr. periods.	Y	Y	Y	Y	Y	Y

139. All information based on (1) the summary of terms of the license agreement for each pool, as set forth on the MPEG LA website, and (2) a review of the license agreements for each pool, which were provided by MPEG LA.

140. "Num.; Geo." is intended to indicate that the pool allocates licensing revenue based on a combined numerical and geographic rationale. For example, the MPEG 2 pool allocates revenues based proportionately on the number of patents held by the licensor in the jurisdiction of manufacture and the jurisdiction of sale.

141. This is not offered to new licensees; however, existing licensees continue to enjoy coverage. *MPEG-4 Systems Introduction*, *supra* note 135.

Appendix C. ICT Patent Pools, Consortia, and Members[142]



Legend:
Administrators: rectangle = administrator; light green = MPEG LA; light blue = Via Licensing; purple = SISVEL; pink = VoiceAge; orange = industry consortium.

Licensors: square = hardware; circle = software; filled triangle = telecom; unfilled triangle = licensing entity; diamond = government-academic; green = East Asia; blue = North America; red = East Asia.

142. This information was current as of July 8, 2014. Size of node indicates degree centrality. For purposes of readability, certain firms were consolidated with their parents, as explained previously, see *supra* note 63. ABA Section of Science & Technology Law members may access a version of the article containing the full-color figure at http://www.americanbar.org/groups/science_technology.html. Nonsubscribers may access a copy of the working paper containing the full-color figure via SSRN at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2431917.