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Patents and Internet Standards

Jorge L. Contreras

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ABOUT THE GLOBAL COMMISSION ON INTERNET GOVERNANCE

The Global Commission on Internet Governance was established in January 2014 to articulate and advance a strategic vision for the future of Internet governance. The two-year project conducts and supports independent research on Internet-related dimensions of global public policy, culminating in an official commission report that will articulate concrete policy recommendations for the future of Internet governance. These recommendations will address concerns about the stability, interoperability, security and resilience of the Internet ecosystem.

Launched by two independent global think tanks, the Centre for International Governance Innovation (CIGI) and Chatham House, the Global Commission on Internet Governance will help educate the wider public on the most effective ways to promote Internet access, while simultaneously championing the principles of freedom of expression and the free flow of ideas over the Internet.

The Global Commission on Internet Governance will focus on four key themes:

- enhancing governance legitimacy — including regulatory approaches and standards;
- stimulating economic innovation and growth — including critical Internet resources, infrastructure and competition policy;
- ensuring human rights online — including establishing the principle of technological neutrality for human rights, privacy and free expression; and
- avoiding systemic risk — including establishing norms regarding state conduct, cybercrime cooperation and non-proliferation, confidence-building measures and disarmament issues.

The goal of the Global Commission on Internet Governance is two-fold. First, it will encourage globally inclusive public discussions on the future of Internet governance. Second, through its comprehensive policy-oriented report, and the subsequent promotion of this final report, the Global Commission on Internet Governance will communicate its findings with senior stakeholders at key Internet governance events.

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ABOUT THE AUTHOR

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ACRONYMS

ABA	American Bar Association
ANSI	American National Standards Institute
BCP	Best Common Practice
CERN	European Organization for Nuclear Research
DARPA	Defense Advanced Research Projects Agency
DSL	digital subscriber line
ETSI	European Telecommunications Standards Institute
FRAND	fair, reasonable and nondiscriminatory
FTC	Federal Trade Commission
GSM	European Groupe Spécial Mobile
HTML	Hyper Text Markup Language
HTTP	Hypertext Transfer Protocol
ICT	information and communications technology
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
ISOC	Internet Society
ITC	International Trade Commission
ITU	International Telecommunications Union
LTE	Long-Term Evolution
MIT	Massachusetts Institute of Technology
NIH	National Institutes of Health
NIST	National Institute of Standards and Technology
NTT	Nippon Telegraph and Telephone Corporation
OASIS	Organization for the Advancement of Structured Information Standards
P3P	Platform for Privacy Preferences
PAG	Patent Advisory Group
PTO	Patent and Trademark Office (United States)
RAND	reasonable and nondiscriminatory
RF	royalty free
RFC	Request for Comments
SEP	standards-essential patent
SDO	standards-development organization
SSO	standards-setting organization
TCP/IP	Transmission Control Protocol/Internet Protocol
W3C	World Wide Web Consortium

We reject kings, presidents and voting.
We believe in rough consensus and running code.

David D. Clark (1992)

EXECUTIVE SUMMARY

In recent years, high-profile lawsuits involving standards-essential patents (SEPs) have made headlines in the United States, Europe and Asia, leading to a heated public debate regarding the role and impact of patents covering key interoperability standards. Enforcement agencies around the world have investigated and prosecuted alleged violations of competition law and private licensing commitments in connection with SEPs. Yet, while the debate has focused broadly on standardization and patents in the information and communications technology (ICT) sector, commentators have paid little attention to differences among technology layers within ICT.

A review of case statistics shows that patent filing and assertion activity is substantially lower for Internet-related standards than for standards relating to telecommunications and other computing technologies. This paper analyzes historical and social factors that may have contributed to this divergence, focusing on the two principal Internet standards bodies: the Internet Engineering Task Force (IETF) and the World Wide Web Consortium (W3C). It offers a counternarrative to the dominant account portraying standards and SEPs as necessarily fraught with litigation and thereby in need of radical systemic change. Instead, it shows how standards policies that de-emphasize patent monetization have led to lower levels of disputes and litigation. It concludes by placing recent discussions of patenting and standards within the broader context of openness in network technologies and urges both industry participants and policy makers to look to the success of Internet standardization in a patent-light environment when considering the adoption of future rules and policies.

INTRODUCTION

Standards and Interoperability

Technical interoperability standards are sets of protocols and design parameters that enable products manufactured by different vendors to work together with minimal user intervention. These standards are embodied in nearly every electronic and technological device today. Broadly adopted interoperability standards can produce significant efficiency-enhancing network effects and other benefits, and are integral to the modern technology infrastructure (Shapiro and Varian 1999; Lemley and Shapiro 2007).

Standards may be developed in a variety of settings. Some health, safety and environmental standards are developed by governmental agencies. Most interoperability standards, however, are developed in the private sector. Individual firms may develop proprietary technologies that, through broad market adoption, become de facto standards (for example, Adobe's "portable document format" or PDF). In several well-known cases (such as Betamax vs. VHS, HD-DVD vs. Blu-ray), competing firms have engaged in commercial "standards wars" to determine which of their proprietary formats will prevail in the market (Shapiro and Varian 1999). Over the past two decades, however, most interoperability standards have been developed by groups of market participants that collaborate within voluntary associations known as standards-development organizations (SDOs).[1] The standards produced within these organizations are often referred to as "voluntary consensus standards," as they are developed through consensus-based collaborative processes and there is no requirement that participants use the resulting standards.

The Architecture of Internet Standardization

According to the Gartner Group (2015), more than six billion devices will be connected to the Internet in 2016. The interconnection and communication of these devices is made possible by hundreds of different standards at many different technological layers. The Transmission Control Protocol/Internet Protocol (TCP/IP) data model provides an abstract representation of the four functional layers of a computing or communications system and is frequently utilized to conceptualize the different technology layers that comprise the Internet. In Table 1, the four TCP/IP layers are shown with a set of exemplary Internet standards, as well as with the SDOs responsible for these standards.[2]

As Table 1 illustrates, there are three distinct groups of SDOs involved in Internet standardization at the different layers of network architecture. The first group focuses on layer 1 — network — which correspond to physical transmission and data link technologies. These include standards for both wired connections (for example, Ethernet, DSL and ISDN [Integrated Services Digital Network]) as well as wireless connections (2G/3G/4G). The major SDOs that serve these technical areas are the European Telecommunications Standards Institute (ETSI) and the Institute of Electrical and Electronics Engineers (IEEE), although a host of smaller SDOs and trade associations are also involved in various aspects of this field. Layers 2 and 3 include the "core" Internet protocols TCP and IP. These standards are maintained by the IETF. At the application layer, the IETF is joined by W3C, primarily responsible

Table 1: Internet Standardization "Stack"

Layer	Standards	SDOs
4. Application	XML (data exchange)	W3C, OASIS
	HTTP, HTML (Web)	IETF, W3C
	IMAP, POP, MIME (email)	IETF
3. Transport	TCP, UDP	IETF
2. Internet	IPv4, IPv6, ICMP, ARP	IETF
1. Network	Ethernet, DSL, Wi-Fi, X.25	IEEE
	3G/4G	ETSI

Note: Acronyms used in this table: ARP — Address Resolution Protocol; DSL — digital subscriber line; HTTP — Hypertext Transfer Protocol; HTML — Hyper Text Markup Language; ICMP — Internet Control Message Protocol; IMAP — Internet Message Access Protocol; IPv4, IPv6 — IP version 4, IP version 6; MIME — Multi-Purpose Internet Mail Extensions; POP — Post Office Protocol; UDP — User Datagram Protocol; XML — Extensible Markup Language. *Source:* Author.

for the HTML descriptor language, and the Organization for the Advancement of Structured Information Standards (OASIS), which focuses on software interfaces.

In order for the Internet to operate seamlessly, the standards defining each of these layers must interface with the layers immediately above and below it. While this technical compatibility has largely been achieved in today's connected devices, there are striking differences among the SDOs that operate at the network, transport/Internet and application levels. One of the largest areas of divergence among these SDOs relates to their treatment of patents.

PATENTS AND STANDARDS

SEPs

A patent is a form of governmental grant that gives its owner the exclusive right to practise (i.e., make, use and sell) a claimed invention throughout the issuing country. Patent protection in most countries lasts for a period of 20 years from the date a patent application is filed. Patents may cover any system, device, product feature, process or improvement, so long as it is useful, novel and not obvious in view of existing technologies. These basic features of patent law are applicable in most developed countries through treaties including, most importantly, the Agreement on Trade-Related Aspects of Intellectual Property Rights (known as the TRIPS agreement).[3] In some countries, including the United States, patents

1 The alternative term "standards-setting organization" (SSO) is also used in the literature.

2 Table 1, of course, grossly oversimplifies the vast array of standards and SDOs involved in Internet technologies. In addition to the listed SDOs, at every layer there are numerous smaller consortia and industry collaborations that may compete or cooperate with the listed SDOs.

3 *Agreement on Trade-Related Aspects of Intellectual Property Rights*, 15 April 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 108 Stat 4809, 1869 UNTS 299.

are authorized for the express purpose of promoting innovation and scientific progress.[4]

While patents have historically covered new machines, compositions of matter and industrial processes, patents covering intangible inventions such as software and methods of doing business began to emerge in the last half century. In the early 1970s in the United States, the Supreme Court began to consider the patentability of inventions embodying computer software. In *Gottschalk v Benson* (1972)[5] and *Parker v Flook* (1978),[6] the Court rejected patents claiming software-based inventions on the ground that they constituted unpatentable mathematical algorithms. But in *Diamond v Diehr* (1981),[7] the Court allowed a patent for an improved method of curing rubber based on a known equation, reasoning that the method should not be rendered patent-ineligible simply because it relied on a mathematical algorithm. This holding opened the door to an increasing number of software-based patents, which were regularly affirmed by the Court of Appeals for the Federal Circuit, a specialized appellate court formed in 1982 for the purpose, among other things, of hearing appeals of patent cases. By the late 1990s, patents on so-called "business methods" were also being recognized by the courts following the Federal Circuit's decision in *State Street Bank & Trust v Signature Financial*.[8]

While recent US Supreme Court decisions are believed to have substantially limited the ability to patent both software and business methods,[9] it is estimated that at least 11,000 Internet-related business method patents are still in force in the United States (Rustad 2014). Outside of the United States, patents on software and business methods are less common, although they may often be upheld if they are tied to a "technical effect" or other outcome in the bricks and mortar world (Adelman et al. 2011).

Like other technologies, the product interface protocols and interoperable designs specified by technical standards are often covered by patents. Most of these patents are owned by one or more firms engaged in the standards-development process.[10] Patents that will always be infringed by a product conforming to a particular standard are referred to as standards-essential patents or SEPs. Complex technological products may implement dozens or even hundreds of standards (Biddle, White and Woods 2010), each of which may be covered by hundreds or thousands of SEPs (Blind et al. 2011). The result is a very large number of patents covering different aspects of certain standards.

Patent Concerns: The Debate over Hold-up and Stacking

The existence of patents covering standards is not inherently problematic, and many argue that the availability of patents provides the financial incentives necessary to fund significant advances in technology. However, once a standard is adopted, patents reduce the ability of competitors to create compatible products and may raise prices for consumers (Scotchmer 2006). Patents are thus two-edged swords when it comes to standardization: they have the potential to tip the balance of benefits and burdens sharply in favour of one group or another.

In the recent literature, commentators have observed two scenarios in which the balance of equities may tip too far in the direction of patent holders: royalty stacking and patent hold-up. Royalty stacking is a type of collective action problem that can occur when multiple SEP holders each charge a royalty to the manufacturer of a standards-compliant product. While any given royalty, viewed individually, might be reasonable and within market norms, the aggregate royalty burden on the product, accounting for hundreds or thousands of SEPs, could be excessive. For example, in *Microsoft v Motorola*, the court observed that

> there are at least 92 entities that own 802.11 SEPs. If each of these 92 entities sought royalties similar to [the patent holder's] request of 1.15% to 1.73% of the end-product price, the aggregate royalty to implement the 802.11 Standard, which is only one feature of the Xbox product, would exceed the total product price.[11]

Such royalty stacking could, if not curbed, impose barriers to market entry, raise prices for consumers and reduce innovation in product markets (US Department of Justice and US Federal Trade Commission [FTC] 2007).

Patent hold-up refers to a scenario in which a SEP holder may demand excessive royalties after product manufacturers have made significant investments in a

4 Article I, Section 8, Clause 8 of The US Constitution authorizes Congress to "promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries" (US Const, art I, § 8, cl 8).

5 409 US 63 (1972).

6 437 US 584 (1978).

7 450 US 175 (1981).

8 149 F (3d) 1368 (Fed Cir 1998).

9 *Bilski v Kappos*, 561 US 593 (2010); *Alice Corp. v CLS Bank International*, 573 US __, 134 S Ct 2347 (2014).

10 SDOs typically hold no patent rights in the standards that they produce.

11 *Microsoft Corp. v Motorola, Inc.*, Findings of Fact and Conclusions of Law, 2013 US Dist Lexis 60233 (WD Wash, 25 April 2013). See also *Ericsson Inc. v D-Link Sys.*, 773 F 3d 1201, 1209 (Fed Cir 2014).

standardized technology. Once such investments have been made, these manufacturers are said to be "locked-in" to the standard (Shapiro and Varian 1999; Farrell et al. 2007). In such cases, the cost of switching from the standardized technology to an alternative may be prohibitive, dramatically increasing a patent holder's leverage in any ensuing licensing negotiation and enabling it to charge excessive royalties (Farrell et al. 2007; Lemley and Shapiro 2007).

A heated debate is currently under way regarding whether patent hold-up and royalty stacking are legitimate threats to standardization and technology markets, or whether they are mere theoretical possibilities.[12] Some argue that there is little empirical evidence of these market failures in the vibrant and rapidly advancing telecommunications marketplace, where prices continue to fall, product capabilities continue to expand and new market entrants continue to appear from all corners of the globe (Galetovic, Haber and Levine 2015). Others, however, respond that there is substantial empirical evidence for the general theory of hold-up, that its application to SEP markets is particularly salient and that evidence of hold-up in these markets is difficult to obtain primarily due to confidentiality restrictions placed on licensing agreements by the parties.[13] It may also be the case that, whatever the theoretical risk of patent hold-up and royalty stacking is in an unregulated SEP market, affirmative measures already taken by SDOs and enforcement agencies may have reduced the occurrence of these behaviours, demonstrating not that hold-up and stacking are not serious issues, but that they must continue to be policed to prevent future occurrences.[14]

SDO Patent Policies

Many SDOs have adopted internal policies intended to reduce the possibility of royalty stacking and patent hold-up. While such policies existed as early as the 1950s (Contreras 2015b), SDO patent policies began to assume their current forms in the late 1990s, prompted by a settlement that Dell Computer reached with the FTC.[15] In this case, the FTC accused Dell of engaging in unfair methods of competition by seeking to enforce patents against implementers of a video bus standard after a Dell engineer had signed a statement certifying that Dell held no patents essential to the standard. In the settlement reached with the FTC, Dell agreed not to assert its patent against any third party implementing the standard.

A second wave of policy revisions occurred in the early 2000s, following litigation involving semiconductor design firm Rambus.[16] In that litigation, the FTC accused Rambus of engaging in anticompetitive practices by concealing — and later seeking to enforce — patents that it otherwise should have disclosed to an SDO. Although Rambus eventually prevailed on technical antitrust law grounds, the case underscored the importance of drafting extremely clear and detailed SDO patent policies.

The result is that today, almost all SDO patent policies impose one or both of the following obligations on SDO participants: an obligation to disclose patents essential to implementation of a standard, and/or an obligation to license patents essential to implementation of a standard, either on a royalty-free (RF) basis, or on a royalty-bearing basis at rates that are "fair, reasonable and nondiscriminatory" (FRAND) (synonymous with "reasonable and nondiscriminatory" [RAND]).[17]

Yet within these parameters, large differences exist among SDO patent policies. These differences can be observed when comparing SDOs in the different layers described in Table 1. Thus, SDOs in the network layer — including ETSI, the International Telecommunications Union (ITU) and the IEEE — typically permit their participants to charge FRAND royalties for SEPs covering the SDO's standards. The primary transport/Internet SDO, the IETF, permits royalties to be charged, but has strong informal norms favouring RF licensing. And application-focused SDOs such as W3C and OASIS largely produce standards subject to RF licensing commitments.[18]

The reasons for these distinctions and what they mean in practice are explored in the remainder of this paper. For the sake of expediency, the paper refers to "Internet" standards as the network and software layer standards that define the Internet and the World Wide Web, as the network standards published by ETSI, the IEEE and others have utility in a wide range of applications beyond the Internet (such as mobile telephony, computer networking, and so on).

12 Some of this literature is summarized in Contreras (forthcoming, 2016a).

13 The author thanks Carl Shapiro for these insights.

14 In this respect, the situation can be analogized to that of Ebola outbreaks in the United States. As of this writing, there is no evidence of a serious Ebola outbreak in the United States. However, this does not mean that Ebola is not a threat to the public health (as there is ample evidence of its seriousness from other jurisdictions). Rather, the absence of Ebola infection in the United States is a credit to its public health agencies and health care facilities, which have carefully monitored, contained and addressed potential outbreaks.

15 In re. *Dell Computer Corp.*, 121 FTC 616 (1996).

16 In re. *Rambus, Inc.*, 2006 WL 2330117, 2006-2 Trade Cas. 75364 (FTC, 2 August 2006), rev'd, 522 F (3d) 456 (DC Cir 2008).

17 In addition to constraints on royalty rates, most SDO patent policies contain a number of additional provisions (Bekkers and Updegrove 2012; ABA 2007; Lemley 2002).

18 More detailed comparisons of the terms of different SDO patent policies can be found in Bekkers and Updegrove (2012) and Lemley (2002).

NETWORK VS. INTERNET STANDARDS: OBSERVED DIFFERENCES IN PATENT DECLARATION AND ENFORCEMENT

Despite the precautionary policy measures taken by many SDOs, over the past decade voluntary consensus standards have become the subject of significant private litigation, regulatory enforcement and policy debate around the world. As one senior US government official lamented in a 2012 address to the ITU, "The world...is awash in lawsuits related to patented technologies" (Hesse 2012, 9).

But although there is a natural tendency to paint all technologies in the ICT sector with the same brush, there are dramatic differences among fields when patents are concerned. Recent studies have shown that the most SEPs have been disclosed, and the most SEP-related lawsuits have been brought, in the wireless telecommunications area. Justus Baron and Tim Pohlmann (2015) collected more than 200,000 patent disclosures from 19 major SDOs. Of these, nearly 170,000 patent disclosures (84 percent) were made at ETSI alone. In contrast, only 667 patents were disclosed as essential to Internet standards developed at the IETF.

Similar contrasts between network and Internet standards emerge when SEP-related litigation is examined. Although the potential for conflict over the setting of FRAND royalty rates was recognized as early as the mid-1990s (Shurmer and Lea 1995, 386), litigation over the level of FRAND royalties did not become a significant phenomenon until five years ago. For example, in both *Apple v Motorola* and *Microsoft v Motorola*, the SEP owner (Motorola) offered to license SEPs covering two widely adopted standards at rates that the potential licensees argued were far in excess of reasonable levels and thus in violation of Motorola's FRAND commitments. In both cases, the manufacturers of standards-compliant products brought breach of contract actions against the SEP owner for the alleged violation of its FRAND commitments, among other things.

Table 2 shows all SEP-related cases that reached judgment in the US federal courts and International Trade Commission (ITC), as well as in courts in Europe and China, as reported by the Essential Patent Blog.[19]

19 Beginning in February 2012, the Essential Patent Blog (www.essentialpatentblog.com) has tracked law and policy developments relating to SEPs and related issues. The cases in Table 2 are limited to those resulting in reported judicial decisions, which represent a small minority of the totality of SEP-related cases that are brought. For a more complete picture of SEP litigation relating to seven widely adopted standards (European Groupe Spécial Mobile [GSM], Universal Mobile Telecommunications System [UMTS], Long-Term Evolution [LTE], H.246, 802.11, Bluetooth and USB), see Contreras (forthcoming, 2016b). For a census of all FRAND-related litigation brought through 2012, see Contreras (2013b).

Table 2: Recent Reported Decisions involving SEPs (2012–2015)

Case	Court(s)	SDO/Standards
Microsoft v Motorola (2012)	W.D. Wash. (jury) 9th Cir.	ITU H.264 IEEE 802.11
Apple v Motorola (2012)	W.D. Wis. N.D. Ill. Fed. Cir.	ETSI UMTS, GPRS IEEE 802.11
Apple v Samsung (2013)	N.D. Cal. (jury) Fed. Cir. ITC	ETSI UMTS
Golden Bridge v Apple (2013)	D. Del.	GSMA W-CDMA (part of ETSI UMTS)
In re Innovatio IP Ventures (2013)	N.D. Ill.	IEEE 802.11
Wi-LAN v Apple (2013)	E.D. Tex. (jury)	ITU CDMA2000 IEEE 802.11
IPCom v Apple (2014)	Germany — Mannheim	ETSI UMTS
NXP v Blackberry (2014)	M.D. Fla. (jury)	IEEE 802.11 JEDEC e.MMC
InterDigital v Huawei, Nokia, ZTE, Nokia (2014, 2015)	ITC D. Del. China — Shenzhen	ETSI UMTS ETSI LTE ITU CDMA2000
Fujitsu v Tellabs (2014)	N.D. Ill. (jury)	ITU G.692
LSI v Realtek (2014)	N.D. Cal. (jury) 9th Cir. ITC	IEEE 802.11
Ericsson v D-Link (2014)	E.D. Tex. (jury) Fed. Cir.	IEEE 802.11
Rembrandt v Samsung (2015)	E.D.Tex (jury)	Bluetooth Special Interest Group
CSIRO v Cisco (2015)	E.D. Tex. Fed. Cir.	IEEE 802.11
Huawei v ZTE (2015)	CJEU	ETSI LTE

Note: Acronyms used in this table: CJEU — Court of Justice of the European Union; e.MMC — Embedded MultiMediaCard; GPRS — General Packet Radio Service; GSMA — GSM Association; W-CDMA — Wideband Code Division Multiple [or Multiplexing] Access. CDMA2000 is a family of third-generation mobile technology standards.
Source: Author.

As Table 2 illustrates, all cases pertained to network standards, either in the field of telecommunications (ETSI and ITU), or computing (Bluetooth and IEEE's 802.11 Wi-Fi standard). Notably absent from the SEP litigation picture, however, are standards pertaining to the Internet/application layers.

At first blush, the lack of patent acquisition and litigation surrounding Internet standards is surprising. After all, nearly every computer, smartphone and tablet in the world communicates via the Internet, and the market for Internet-enabled devices is enormous, suggesting that potential verdicts might present lucrative incentives for litigation. Why, then, have the patenting and litigation trends observed among network technologies not affected the Internet? The remainder of this paper addresses this question.

WHAT THE INTERNET IS NOT (YET)[20]

In many respects, the differences in patenting and standardization practices between the network and Internet/application layers may be explained by differences in their historical development and technical architectures. While the layperson may see no discernible difference between the 4G LTE standard that enables his or her smartphone to connect to a mobile network and the TCP/IP protocols that define the size and configuration of the data packets that traverse that network, these two technical areas exist across a significant gulf of history that has shaped the policies and norms that characterize these industries today.[21]

Telecommunications Technology and Patents

Differences in patenting patterns among network and Internet/application layer technologies may, in part, be explained by inherent technological differences between these layers. Lower-level network technologies, which are more closely tied to physical hardware, may be more susceptible to patent protection than higher-level Internet and application layer technologies, which are more akin to software-based inventions, for which patents may be less common[22] (Lehr 1995). Moreover, wireless telecommunications technologies have generally evolved in discrete generations, each lasting several years (for example, 2G to 3G, 3G to 4G), with each upward shift requiring significant infrastructural, manufacturing and marketing expenditures. Given these costs, the incremental cost of even heavy patenting could appear both small in comparison to overall expenditures, and worthwhile, to protect those sunk investments.

In addition to dealing with technologies that may generally be more prone to protection by patents, holders of patents in the network area may be more likely to declare even marginal patents as essential to network-based standards. Studies by David J. Goodman and Robert A. Myers (2005) and Fairfield Resources, Inc. (2007) have found that only 27 percent and 28 percent of patent families declared as "essential" to ETSI's GSM and W-CDMA standards, respectively, are actually essential to implementation of those standards. Interviews conducted by Knut Blind et al. (2011) also point to widespread over-disclosure of patents at SSOs.[23] In addition to over-disclosure, higher levels of patent declaration at ETSI could arise from factors such as the intentional inclusion of optional and non-essential patented features in ETSI standards, more feature-rich standards in general and greater granularity in patent claim drafting.[24]

The Roots of Telecommunications Standardization

Standardization in the telecommunications sector began not as a cooperative effort among competing firms, but as a (largely successful) attempt by national telephone monopolies to preserve their control over the industry. This approach was epitomized by AT&T in the United States, which operated under the telling slogan "One System, One Policy, Universal Service" (Russell 2014, 97; Wu 2010, 51). As described in detail by Andrew Russell (2014), AT&T standardized many aspects of the US telephony system to ensure that it could obtain a consistent and reliable supply of components from subcontracted manufacturers and to enable local exchanges to connect to its long-haul lines and thereby avoid competition in the long-distance market (ibid.).

Other national operators in Europe and Asia exerted similar levels of control. In Japan, for example, telecommunications standardization was largely driven by its century-old national telecommunications monopoly, Nippon Telegraph and Telephone Corporation (NTT).

20 The title of this section owes a debt to Jonathan Zittrain's influential 2009 book *The Future of the Internet — And How to Stop It*, a cautionary tale about the direction that the Internet could take under increased regulation.

21 A decade ago, Suzanne Scotchmer (2006) recognized the fundamental differences between Internet and telecom standards, even before the most recent wave of SEP-related litigation. Yet the debate today has lost sight of many of these distinctions.

22 See the section on SEPs above.

23 There are several possible reasons that over-disclosure of patents may occur at SSOs. For example, SSOs may require declaration of patents at the application stage, before the actual scope of claims are known. Moreover, antitrust enforcement agencies have brought actions against firms that allegedly failed to disclose patents essential to particular standards, thus creating a significant motivation to disclose all patents that might, under any interpretation, be considered essential. See Contreras (2013b) for a more detailed discussion of these possible motivations.

24 This area is ripe for further empirical study.

For decades, NTT, with the backing of the Japanese government, designed Japan's telecommunications infrastructure and supported a dedicated "family" of equipment manufacturers including Hitachi, Fujitsu and NEC (Kushida 2008). The NTT network was, until recently, characterized by proprietary standards developed in NTT's research labs and mandated by the national Ministry of Posts and Telecommunications for deployment by NTT's dedicated suppliers (ibid.).

In most countries, wireless telecommunications were not as heavily regulated as wireline communications, but scarce spectrum still invited governmental allocation and control, and standards were adopted at national and regional levels (Cowhey, Aronson and Richards 2006; Shurmer and Lea 1995). The contest among competing technologies frequently involved wrangling over patents. While first-generation analog wireless technologies represented a patchwork of largely incompatible, vendor-specific technical approaches, by the early 1980s the industry recognized the need for second-generation or 2G digital wireless telecommunications standards that would support both voice and data communications.

In Europe, ETSI was the focal point for the development of 2G and subsequent wireless standards. It was clear beginning in the late 1980s that patent issues at ETSI would be contentious, leading to a series of policy amendments and debates within the organization (Shurmer and Lea 1995, 391–93). During that period, Ericsson promoted a 2G standard based on time-division multiplex access technology, which eventually led to the GSM standard. Ironically, the largest holder of SEPs in GSM technology was Motorola, a US firm that conducted significant research and development operations in Europe (Bekkers, Verspagen and Smits 2002). A competing 2G proposal was advanced by a coalition of French and German firms, which had strong patent positions in their own technology (ibid.). Before this coalition agreed to support GSM at the newly formed ETSI, technology covered by some of these patents had to be included in the standard (Lundqvist 2014, 59). By the time GSM was approved by ETSI in 1990, five firms (Ericsson, Nokia, Siemens, Motorola and Alcatel) held broad patent coverage of the standard (Bekkers, Verspagen and Smits 2002).

The situation in the United States was less fractured, but even more patent-centric, as Qualcomm's CDMA technology became the basis for the leading 2G standard (Lundqvist 2014, 59). And, as noted above, each successive generation of wireless telecommunications standards has been burdened with more patents, opening the way for further disputes and litigation.

The Early Internet and Patenting

In contrast to telecommunications and other network technologies, the Internet was designed as a hardware-neutral set of protocols for connecting heterogeneous computer networks. It was initially conceived and funded by the US Department of Defense though its Defense Advanced Research Projects Agency (DARPA, also known as the Advanced Research Projects Agency, or ARPA; the agency changed its name periodically).[25] The project sought to design a reliable and resilient computer network that did not rely on the then dominant circuit-switched technology.[26] Building on theoretical work done at the Massachusetts Institute of Technology (MIT) and the Rand Corporation in the early 1960s, host computers at the University of California, Los Angeles; Stanford; University of California, Santa Barbara; and the University of Utah were connected in 1969 to form a prototype packet-switched network known as ARPANET. In 1973, Robert Kahn at DARPA and Vint Cerf at Stanford University developed the TCP/IP protocols to enable ARPANET to connect with other computer networks, laying the groundwork for the modern Internet.[27]

The pioneers of the Internet were employed primarily by the US government, its academic collaborators and a handful of private contractors (such as the Cambridge, MA-based Bolt, Beranek and Newman), leading to a distinctly non-commercial culture (Nickerson and zur Muehlen 2006). Large firms such as IBM and AT&T that were heavily invested in patenting activity were not part of the early Internet (Russell 2014). And in the days before the Bayh-Dole Act of 1980,[28] which provided a framework for patenting federally funded inventions, universities

25 The origins of the world's largest network have been documented many times. See, for example, Hafner and Lyon (1996), Segalier (1998), Wu (2010), Russell (2014) and DeNardis (2014).

26 Paul Baran at the Rand Corporation was one of the early theorists of distributed computing. He believed that a distributed network was more likely to survive a nuclear attack than a network dependent on end-to-end switching, as the existing AT&T network was. See Baran (1964), in particular the memorandum "directed toward examining the use of redundancy as one means of building communications systems to withstand heavy enemy attacks." See also Hafner and Lyon (1996, 54–58). Some recent commentators have questioned whether nuclear survival was the driving force behind ARPANET, arguing instead that developing remote time-sharing capability was the primary motivation for DARPA's interest in distributed computing. See, for example, Ian Peters' "History of the Internet," at www.nethistory.info/History%20of%20the%20Internet/beginnings.html.

27 The original TCP protocol was published in December 1974 as Request for Comments (RFC) 675, and the IP protocol was published in 1981 as RFC 791. The IETF document series extends back to a series of academic RFCs first published in 1968. The term RFC has in recent years lost its meaning and now simply refers to the definitive standards and reference document series published by the IETF. See DeNardis (2014, 71-72).

28 *Patent and Trademark Law Amendments Act* (Pub L 96-517, 12 December 1980). The Bayh-Dole Act both authorized and encouraged universities and other government contractors to patent inventions funded by federal agencies. Prior to the act, there was no uniform federal policy regarding patenting of federally funded inventions, and most of these inventions were not patented.

and federal agencies engaged in only sporadic patenting activity. Compounding this general disregard for patents was the legal understanding during the 1960s and 1970s that computer software and algorithms, the regime in which Internet standards were being developed, were simply not patentable (see the section on SEPs above). The combination of these factors resulted in few patents being filed on the fundamental protocols that defined the Internet (Weitzner 2004).

As personal computers, workstations and local area networks proliferated in the 1980s, the Internet expanded in size and popularity. Yet, despite its growing usage among businesses and the general public, Internet standards remained hardware-neutral and relatively lean.[29] This ongoing separation from the patent-rich hardware network layer may have left key design features of the Internet as less obvious targets for patenting, even by the commercial enterprises that soon became integral to its development and deployment, and even after the emergence of software and business method patents in the 1980s and 1990s.

THE IETF

The Origins and Growth of the IETF

Prior to 1985, technical work relating to the Internet was carried out in a series of task forces chaired by leading researchers at DARPA and a few universities. In 1985, this activity was placed under the umbrella of a new, loosely organized body — the IETF. Around this time, Kahn and other leaders of the Internet project departed from DARPA, leaving the IETF and its sister organization, the Internet Activities Board (now the Internet Architecture Board, known as the IAB), to chart the future direction of the Internet.

As the Internet grew in popularity and usage, commercial users rapidly began to outnumber academic and government users. In order to create an organization in which commercial, academic and government representatives could collaborate, a non-profit corporation called the Internet Society (ISOC) was formed in 1992 (Lehr 1995, 153; DeNardis 2014, 70). ISOC became the "organizational home" of the IETF in 1996 and still provides administrative, personnel and financial support to the IETF.[30]

Participation in the IETF is, and always has been, on an individual basis, although firms often sponsor attendance and participation by their employees. In recent years, more than a hundred different working groups have been operational within the IETF at any given time (Hoffman 2012), and between 1,200 and 1,500 individuals regularly attend its meetings, which are held three times a year (Contreras 2014). The IETF is famously open and transparent (Whitt 2013; Froomkin 2003; Lessig 2001). Almost all proceedings, documents and records are freely available on the IETF website, and anyone who is interested may join a technical working group. Documents that advance through the "standards track" are based on open consensus processes overseen and managed by a group of semi-elected area directors and other leaders. The IETF standardization process is largely bottom-up, wherein technical proposals are generated by individual participants who must defend and advocate their proposals both in written email communications and at in-person IETF meetings.

While the IETF's open culture and transparent procedures have been applauded (Froomkin 2003), they have also shown weaknesses. Most notably, the speed of standardization at the IETF has flagged, and the organization has become notorious for lengthy technical debates and delays (Simcoe 2007). As discussed below, this slowdown contributed to Tim Berners-Lee's formation of W3C as an independent organization in 1994.

Patents at the IETF

Evolution of the IETF Patent Policy

The IETF's first formal policy regarding patents[31] was adopted in 1992 to accommodate the growing community of commercial Internet users. This policy, largely mirroring the language of the American National Standards Institute's (ANSI's) patent policy,[32] contained a rudimentary FRAND or RF licensing requirement.

Patents played little role in IETF deliberations until 1995, when Motorola disclosed patents claiming features of the PPP[33] Compression Control Protocol (known as CCP, RFC 1962) and PPP Encryption Control Protocol (known

29 As explained by Lehr (1995, 137), Internet standards tend to support "minimal functionality at least cost," in contrast to hardware-specific standards supporting a range of specialized services.

30 See RFC 2031, "IETF-ISOC Relationship" (1996), https://tools.ietf.org/html/rfc2031.

31 RFC 1310, "The Internet Standards Process" (March 1992), https://tools.ietf.org/html/rfc1310.

32 Although ANSI is not itself an SDO, it accredits US SDOs as developers of American national standards. Among ANSI's requirements for accredited SDOs, which are embodied in its *Due Process Requirements for American National Standards*, are rules regarding the way that accredited SDOs must handle patents held by their participants (see *ANSI Essential Requirements: Due Process Requirements for American National Standards*, ANSI, § 3.1.1 [January 2015]). Although the IETF is not an ANSI-accredited SDO, its first patent policy was borrowed largely from the ANSI *Essential Requirements*.

33 PPP refers to Point-to-Point Protocol. The PPP CCP and PPP ECP are known collectively as the PPP standards.

as ECP, RFC 1968) (Simcoe 2007).[34] Motorola initially refused to commit to license these patents to users of the PPP standards, leading to significant opposition within the IETF working group.[35] The IETF eventually published the PPP standards with the patented technology, but only after Motorola agreed to offer implementers of the standard licenses on RAND terms.[36]

The PPP incident led the IETF to review and revise its patent policy as part of a 1996 overhaul of its standardization procedures (RFC 2026). The 1996 policy departs from the IETF's earlier RAND/RF licensing commitment; it only requires that participants disclose the existence of known patents covering IETF standards,[37] but not that the patents be licensed on any particular terms. The IETF's current policy (contained in RFC 3979 and subsequent addenda, collectively known as Best Common Practice [BCP] 79) preserves this disclosure-only approach.[38]

The IETF's Preference for RF

Given IETF participants' discomfort with Motorola's RAND licensing proposal for PPP, it may seem curious that the IETF elected to adopt a policy with no licensing commitment at all. That is, the IETF's 1992 policy at least contained an upper bound on royalties charged by participants ("reasonableness"), whereas the 1996 policy gives SEP holders carte blanche to charge anything they wish, or even to withhold licenses entirely.

But this seeming flexibility is, in practice, an illusion. Rather than empower SEP holders to charge high or unreasonable royalties for their patents, it actually discourages them from charging anything at all. How? If an SDO policy expressly permits a SEP holder to charge RAND royalties, then such royalties are effectively condoned by the organization. But if a policy neither permits nor prohibits royalties, then all decisions regarding royalty-bearing technologies will be pushed down to the organization's working groups. As such, the IETF continues to exhibit a strong preference for RF standards. It does so in two ways: through express statements of preference in BCP 79 and elsewhere, and through working group deliberations.

RF Policy Preferences

While the IETF does not require its participants to commit to license their patents on any particular terms, reasonable or otherwise, it does express a preference for RF standards in many contexts. For example, according to Section 8 of BCP 79

> In general, IETF working groups prefer technologies with no known [patent] claims or, for technologies with claims against them, an offer of royalty-free licensing. But IETF working groups have the discretion to adopt technology with a commitment of fair and non-discriminatory terms, or even with no licensing commitment, if they feel that this technology is superior enough to alternatives with fewer [patent] claims or free licensing to outweigh the potential cost of the licenses.[39]

Thus, the preference for RF standards at the IETF is just that: a preference, and one that is not universally shared. However, the express statement of that preference is telling.

Additional evidence of the IETF community's preference for RF is displayed in connection with specific technology areas, such as Internet security. In these areas, which are viewed as critical for Internet integrity, the institutional preference for RF standards is articulated more strongly:

> An IETF consensus has developed that no mandatory-to-implement security technology can be specified in an IETF specification unless it has no known [patent] claims against it or a royalty-free license is available to implementers of the specification unless there is a very good reason to do so.[40]

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34 One earlier patent disclosure at the IETF was made in 1993 by the National Institute of Standards and Technology (NIST) relating to a patent covering its Digital Signature Algorithm. However, NIST committed to license the patent to users worldwide on an RF basis, eliminating any serious concern. See Reported Statement from NIST Regarding Use of DSA (23 July 1993), https://datatracker.ietf.org/ipr/449/.

35 See IETF Working Group mail archive at https://groups.google.com/forum/#!msg/info.ietf/raixEKiWbMc/IPK9BQuXjnoJ.

36 See RFC 1915, "Variance for the PPP Connection Control Protocol and the PPP Encryption Control Protocol" (1996), https://tools.ietf.org/html/rfc1915.

37 As noted in the section "Origins and Growth of the IETF" above, participation in the IETF is on an individual, rather than an organizational, basis. Thus, individual IETF participants must disclose any patents held or controlled by themselves or by their employers or sponsors. RFC 3979, "Intellectual Property Rights in IETF Technology," Sec 6.1 (2005), https://tools.ietf.org/html/rfc3979. However, because individuals must only disclose patents "reasonably and personally" known to them, it is possible that some relevant patents held by an organization may not be required to be disclosed by an individual employee of that organization. The author is unaware of such a situation ever having become an issue at the IETF.

38 IETF patent disclosures are published and archived at www.ietf.org/ipr.

39 RFC 3979, "Intellectual Property Rights in IETF Technology," Sec 6.1 (2005), https://tools.ietf.org/html/rfc3979.

40 Ibid., Sec. 8.

Thus, while the IETF lacks strict positive rules requiring RF standards, these statements are reflective of broadly held community norms. Accordingly, while room is left for the IETF to adopt an Internet security standard that is subject to royalties if "there is a very good reason to do so," it does not appear that such a reason has ever been found.

Working Group Deliberations

IETF working groups are charged with considering and evaluating the implications of patent burdens on technologies being considered for standardization. RFC 3669, which offers guidance to IETF working groups, states that

> every working group…needs to take [intellectual property rights] seriously, and consider the needs of the Internet community and the public at large, including possible future implementers and users who will not have participated in the working group process when the standardization is taking place.[41]

In addition to statements of preference in IETF policy documents, IETF participants and working groups exhibit their own preferences for RF standards in the selection of technical proposals for standardization. The fact that patents must be *disclosed* to the IETF early in the standardization process enables participants to evaluate the extent to which patented technologies may be essential to standards under development. If the members of a working group do not wish to include a patented technology in the standard, they have the opportunity to redesign the standard to avoid the relevant patents.

Thus, while explicit group negotiation of patent royalty rates is discouraged,[42] working group members are advised to consider the potential impact of proposed licensing terms on the usefulness of a technology under consideration for standardization.[43] In practice, IETF working group participants have exhibited a keen awareness of which technical proposals are burdened by potential patent royalties and take this information into account when designing standards.[44]

Voluntary Licensing Disclosures

Decisions regarding the inclusion of patented technologies in IETF standards is facilitated by voluntary disclosures that SEP holders may make regarding their licensing intentions. Thus, while patent disclosures at the IETF must contain certain key information such as patent numbers or affected standards, the IETF also permits the disclosure of additional relevant information. Accordingly, many IETF participants make express licensing commitments in their patent disclosures.[45] These can include commitments to license the disclosed SEPs on RAND or RF terms, as well as broad commitments not to assert patents in particular contexts.

Not surprisingly, given IETF's stated preferences, many voluntary licensing commitments indicate that RF licensing of SEPs will be offered. In a study covering the period 2007–2010, Jorge L. Contreras (2013a) analyzed 481 patent disclosures made at the IETF, covering a total of 594 different standards documents. Of these disclosures, 283 (59 percent) contained voluntary commitments to license the disclosed SEPs on RF terms or the equivalent. These data reveal strong community alignment behind the elimination of patent encumbrances on IETF standards.

The strength of the IETF's community norms around RF patent licensing is further exemplified by the agreement even of IETF participants with well-known patent monetizing programs not to assert their SEPs under certain circumstances.[46]

W3C

The Origins of W3C

By the late 1980s, the European Organization for Nuclear Research (CERN) was a key European Internet node (DeNardis 2014, 74). Around 1989 Tim Berners-Lee, a young software engineer at CERN, began work on improving the Internet's user interface to facilitate scientific collaboration and data exchange both within CERN and

41 RFC 3669, "Guidelines for Working Groups on Intellectual Property Issues" Sec. 5 (2004), https://tools.ietf.org/html/rfc3669#section-5.

42 Potential antitrust concerns arise in the context of such group negotiations. Non-lawyer IETF working group leaders do a good job of curbing these discussions. See, for example, the 2009 email list discussion of the Robust Header Compression standard, in which a working group leader writes, in typical tongue-in-cheek IETF fashion, "please do *not* discuss specific patents/patent claims on the mailing list, as such a discussion might require a number of contributors to unsubscribe and stop contributing. (It might also cause you or your employer to become liable for damages in interesting ways.)…If you want to discuss this, meet in a hallway and make sure no microphones are nearby." See www.ietf.org/mail-archive/web/rohc/current/msg05691.html.

43 See IETF, RFC 3669, "Guidelines for Working Groups on Intellectual Property Issues" at Sec. 5.6 (2004).

44 For examples of potential patent issues considered by IETF working groups, see IETF, RFC 3669 "Guidelines for Working Groups on Intellectual Property Issues" at Sec. 4 (2004) (detailing patent issues arising in connection with standardization efforts for IP Storage, Privacy-Enhanced Mail and public key infrastructure, Virtual Router Redundancy Protocol and Secure Shell).

45 The enforceability of such commitments in the absence of a formal contractual framework is discussed in Contreras (2015a).

46 See, for example, https://datatracker.ietf.org/ipr/2554/, in which Qualcomm commits not to assert SEPs against implementers of IETF RFC 6330 so long as the standard is not implemented in a device that uses a wireless wide-area standard (for example, a mobile phone).

with external collaborators. In doing so he developed HTTP and HTML,[47] which became the foundational protocols for the World Wide Web. Berners-Lee, heavily influenced by the open source software movement, released his code online in 1991 (Russell 2011).

The graphically oriented World Wide Web was a significant improvement over existing text and directory-based file sharing systems such as Gopher and FTP. Enthusiasm for the Web grew rapidly among academic researchers. Berners-Lee, aware that researchers were likely to tinker with and improve his original Web protocols, recognized the need to standardize the technology to avoid fragmentation and proliferation of incompatible versions. His first efforts at publishing the Web protocols as standards were made at the IETF.[48] He was discouraged, however, by the slow and contentious deliberations at the IETF, and decided that the Web would best be served by a new and more flexible standardization body (Russell 2011).[49] In 1994 Berners-Lee left CERN for MIT, which became the home of a new SDO devoted to Web standards, W3C. Berners-Lee brought the page descriptor language HTML to W3C, while leaving HTTP at the IETF, where it continues to be maintained.

Soon after MIT became the base for W3C, several other universities in Europe and Asia joined W3C as organizational hosts. W3C received early funding from DARPA and the European Union. It later shifted to a self-sufficient member fee funding model (DeNardis 2014).

Patents and W3C

The Increasing Relevance of Patents to the Web

The open source movement was, to a large extent, a reaction to increases in intellectual property protection for computer software. As noted above, by the late 1980s and 1990s, an increasing number of software-related patents were being issued in the United States and growing numbers of lawsuits were being brought to enforce these patents (Besen and Meurer 2008, chapter 9). In addition, patents purporting to cover various broad categories of Internet technology, including British Telecom's 1989 patent that it claimed to cover the entire hyperlinked Internet, drew increasing press coverage and public concern, along with some ridicule from the technical community.[50] According to Richard Stallman, one of the founders of the "free" software movement, "the worst threat we face comes from software patents" (Stallman 1999).

In 1993, the University of Minnesota, which developed the popular Gopher Internet file sharing system, announced that it would begin to charge commercial users (Russell 2011). This announcement raised concerns among many Internet users, and prompted Berners-Lee to seek assurances from his own employer, CERN, that it would not do the same with the Web (ibid.) Later that year, CERN agreed to contribute its intellectual property rights in the code underlying the Web to the public domain to "further compatibility, common practices, and standards in networking and computer supported collaboration" (CERN 1993).

Given W3C's origins in the scientific research community, the first five years of its existence were relatively free from patent-related controversy. As Berners-Lee (2004) observed of that period:

> Many participants in the original development of the Web knew that they might have sought patents on the work they contributed to W3C, and that they might have tried to secure exclusive access to these innovations or charge licensing fees for their use. However, those who contributed to building the Web in its first decade made the business decision that they, and the entire world, would benefit most by contributing to standards that could be implemented ubiquitously, without royalty payments.

But, as noted in the introduction of this paper, throughout the 1990s patents were becoming an increasingly important force in the commercial world. Patent concerns finally reached W3C in 1999. That year, Microsoft and Sun Microsystems disclosed patents covering W3C's CSS (cascading style sheets) and XLink technical proposals, respectively, and a small company called Intermind obtained a patent claiming key aspects of W3C's Platform for Privacy Preferences (P3P) standard (Weitzner 2004; Russell 2011). W3C feared that Intermind's royalty demands would chill adoption of the P3P standard. As a result, it engaged a prestigious New York law firm to opine that P3P did not infringe Intermind's patent (Pennie & Edmonds LLP 1999). Eventually, Intermind backed down and P3P was released without the threat of patent infringement. Nevertheless, the Intermind incident caused W3C to re-evaluate its informal "gentlemen's agreement"

47 HTML is an application of International Organization for Standardization Standard 8879:1986 Information Processing Text and Office Systems; Standard Generalized Markup Language (Berners-Lee and Connolly 1995).

48 Berners-Lee submitted a version of HTML for standardization to the IETF in June 1993 (see www.w3.org/MarkUp/draft-ietf-iiir-html-01.txt). The standard was published by the IETF as RFC 1866 in November 1995 (Berners-Lee and Connolly 1995).

49 It has also been suggested that Berners-Lee preferred a standardization process over which he exerted more direct control. In this regard, W3C has been referred to as a "benevolent dictatorship," one in which the ultimate authority lies in the organization's director (Eygedi 2001, 40-41).

50 *British Telecom. v Prodigy Comms.*, 189 F Supp (2d) 101 (SDNY 2002), 217 F Supp (2d) 399 (SDNY 2002).

whereby participants would not seek to patent W3C standards.

W3C's RF Patent Policy

In 1999, W3C began the arduous task of developing a formal patent policy. Daniel J. Weitzner (2004) offers a detailed account of this lengthy and contentious process. The first policy that W3C's drafting group developed included requirements relating both to patent disclosure and patent licensing. The patent licensing provisions were the most controversial because they would have required W3C members to license SEPs to all implementers of W3C standards on RF or RAND terms. The possibility that monetary royalties could be charged on W3C standards alarmed some W3C participants and members of the public, particularly the Open Source Initiative (2001) and other open source software developers and advocates. They claimed that large corporate interests within W3C were attempting to "hijack" the organization and subvert its historically open tradition. W3C received nearly 2,500 public comments on the draft policy, mostly opposing it.

This reaction from the open source community sent W3C back to the drawing board. In 2002, after extensive internal discussion and debate, W3C proposed a new patent policy, this time requiring RF licensing by all members of the W3C working group that developed a standard. Berners-Lee (2004) justified the move to an RF model as follows:

> The open platform of royalty-free standards enabled software companies to profit by selling new products with powerful features, enabled e-commerce companies to profit from services that [sic] on this foundation, and brought social benefits in the non-commercial realm beyond simple economic valuation. By adopting this Patent Policy with its commitment to royalty-free standards for the future, we are laying the foundation for another decade of technical innovation, economic growth, and social advancement.

To accommodate the concerns of some of its corporate members, the W3C policy included an exception which allowed the inclusion of patented technologies in W3C standards, but only after a "Patent Advisory Group" (PAG), comprising representatives of all working group members and the chair of W3C, determined that the patented technology was essential to the standard and could not be worked around. The new version of the patent policy was approved and went into effect in 2004, the tenth anniversary of W3C's formation. The policy remains in effect today with only minor revisions.[51]

The new W3C patent policy was not universally applauded by W3C members, and it has been reported that the RF requirement caused large patent holders such as IBM, SAP and Microsoft to bring standardization proposals to SDOs with more patent-friendly policies (Festa 2003; Russell 2011).[52] Nevertheless, some of these firms eventually expressed support for the policy, acknowledging the growing importance of open source software to the Web ecosystem.

Since W3C's RF policy went into effect, there have been relatively few invocations of the PAG process. One of the first arose in 2003, when a PAG was formed to assess the potential impact of four patents on W3C's draft VoiceXML standard (Voice Browser PAG 2003). The PAG approached the owners of the four patents and received a commitment of RF licensing with respect to two of them, and an assurance that the owner of the third did not consider the patent to be essential to the standard. But Rutgers University, the owner of the fourth patent, did not make any commitment regarding the patent and seemingly reserved its right to seek royalties against implementers of the standard. W3C proceeded to adopt the standard in the face of this threat, and it appears that Rutgers did not actively seek to enforce the patent.

A more contentious incident arose, also in 2003, with respect to a patent held by a small firm called Eolas, which allegedly covered a key aspect of the HTML standard (Weitzner 2004). After Eolas obtained a US$521 million infringement verdict against Microsoft's Internet Explorer browser, W3C convened a PAG to assess the potential impact of the Eolas patent on HTML. As a result of the PAG, W3C petitioned the US Patent and Trademark Office (PTO) to re-examine the Eolas patent. In a letter to the PTO, Berners-Lee (2003) expressed the concerns of the PAG and the broader Web community:

> The impact of the [Eolas] '906 patent reaches far beyond a single vendor and even beyond those who could be alleged to infringe the patent. The existence of the patent and associated licensing demands compels many developers of Web browsers, Web pages, and many other important components of the Web to deviate from the fundamental technical standards that enable the Web to function as a coherent system…

51 See www.w3.org/Consortium/Patent-Policy-20040205/.

52 SDOs face the risk that members will depart with any controversial policy change. Such fears arose in 2007 when the small SDO VITA amended its patent policy to require members holding SEPs to disclose their maximum royalty rates prior to approval of a standard. Despite vigorous opposition, only one member, Motorola, actually withdrew from VITA as a result of the policy change (Contreras 2013a). Similar concerns have been raised in the wake of recent policy amendments by the IEEE.

> The barriers imposed on the information technology industry by the '906 patent are of such concern because they cause fragmentation in the basic standards that weave the Web together. Denial of access to any particular technology is a problem that engineers can successfully address, provided they have knowledge of the barrier before it becomes part of a standard. However, as the '906 patent threatens widely deployed, standard technology, the damage is magnified. If the '906 patent remains in force, Web page designers and software developers will face a dangerous dilemma. They may comply with globally-recognized Web standards resulting in an inadequate user experience of their content. Or, they may attempt to design to the various work-arounds chosen by different browser developers and face the uncertainly of not knowing who will be able to use their content or applications properly. W3C's development and the industry's acceptance of a single common base of standards for Web infrastructure arose out of a need to avoid just this sort of dilemma. The '906 patent is a substantial setback for global interoperability and the success of the open Web.

The Eolas patent was eventually invalidated by the PTO on the basis of prior art presented by W3C (Weitzner 2004).

Despite these relatively high-profile incidents and the large number and significance of standards published by W3C, only a handful of PAGs have been formed to investigate patents not subject to RF licensing commitments. During the first 10 years of the RF patent policy, a mere 12 PAGs were formed, all of which resolved the relevant issues without serious disruption of W3C's standardization activities (W3C Patent and Standards Interest Group 2013). It thus appears that the RF policy at the W3C has largely been a success.

CONCLUSION: THE LOGIC OF RF

As this paper shows, the primary SDOs responsible for Internet standards, the IETF and W3C, have evolved strong policies and norms favouring RF standards. This approach has likely contributed to the relatively low level of patent litigation relating to Internet standards in comparison with network standards.

The preference for RF standards at the IETF and W3C can be traced, in part, to the historical origins of these groups in academia and government and their ties to the open source movement. Scotchmer (2006, 307) called the circumstances resulting in the open Internet "one of the most fortunate accidents in industrial history."[53]

But the IETF and W3C today are dominated by private firms that are as motivated by profit as their counterparts in the network space. Their reasons for favouring RF models are not entirely ideological or altruistic. A range of commercial considerations motivate firms to relinquish potentially profitable exploitation of their patent rights in the service of broader commercial goals, such as the seeding of new markets, the establishment of technological leadership and the desire to achieve industry-wide interoperability (Contreras 2015c).

Whatever the reasons for its development, the RF patent landscape of the Internet has yielded significant benefits (Scotchmer 2006; DeNardis 2014). It has enabled substantial innovation and experimentation, it has yielded entirely new industries such as social media and it has facilitated virtually unrestricted market entry and competition.

Defenders of patent monetization argue that a financial return on patents is necessary to fuel innovation and product development in complex and rapidly advancing technologies. There is clearly some truth to this assertion, and a recognition in no less than the US Constitution that patents are intended to promote innovation. However, proponents of strongly monetized patent structures may lose sight of the innovation that could potentially be enabled by *lowering* barriers to technology markets.[54]

Today's debate over SEPs and patent monetization is really just one skirmish in a much larger war over openness and closure in technology networks. Scholars including Larry Lessig (2001; 2006), Jonathan Zittrain (2009), Milton L. Mueller (2002), Tim Wu (2010) and Laura DeNardis (2009; 2014) have warned about the consequences of over-regulating, closing and monetizing the Internet. The open and RF nature of the Internet was not pre-ordained and it may not last forever. Slight changes in history could

53 See also Lehr (1995), attributing the success of the Internet in part to "historical accident."

54 In a way, today's patent monetization justifications echo those made by AT&T in the heyday of the telephony monopoly. As Tim Wu (2010) has described it, AT&T justified its state-sanctioned monopoly, in part, by arguing that the resulting rents were plowed back into research and development at facilities like Bell Laboratories, where no fewer than seven Nobel laureates hung their hats and to which we owe the transistor and many other technological marvels. Yet in hindsight, Wu points out, these arguments ring hollow. After all, the basic residential telephone unit remained essentially unchanged for 40 years, notwithstanding the brain trust at Bell Labs. What's more, AT&T imposed a daunting array of intellectual property, regulatory and commercial barriers to block any innovator who sought to improve telephony in the slightest degree (culminating in the notorious "Hush-a-Phone" debacle). When the Federal Communications Commission finally grew skeptical of the monopoly's virtue and ordered the standardization of telephone jacks via the now-ubiquitous RJ-11 connector, an explosion of innovation occurred leading to the introduction of connected devices including fax machines, answering machines and speaker phones (ibid.).

have sent the Internet off in very different directions. Just as a single meteor or climatic event can shift the course of biological evolution, so can a single judicial decision or regulatory pronouncement change the course of a technology field. It is unlikely that many today would prefer to live in a world in which most content is meted out by commercial networks, as it was in the 1980s under pay services such as America Online (AOL), CompuServe and Prodigy. Could the proliferation of patents on fundamental interoperability standards nudge us back in this direction?[55]

Rapid technical change will occur in the near future with the advent of the Internet of Things, the Smart Grid,[56] 3D printing, wearable devices and other technological advances. Each of these developments will require new standards and common protocols that build on top of the existing Internet infrastructure. Let us hope that these new technologies remain as open to future innovation and competition as the Internet is today.[57]

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55 Walter Isaacson (2014) describes a similar alternative pathway that the Internet might have taken had Ted Nelson's system of two-way links prevailed over Berners-Lee's hyperlinks:

> Had Nelson's system of two-way links prevailed, it would have been possible to meter the use of links and allow small automatic payments to accrue to those who produced the content that was used. The entire business of publishing and journalism and blogging would have turned out differently. Producers of digital content could have been compensated in an easy, frictionless manner, permitting a variety of revenue models, including ones that did not depend on being beholden solely to advertisers. Instead the Web became a realm where aggregators could make more money than content producers….But a system of two-way links and micropayments would have required some central coordination and made it hard for the Web to spread wildly, so Berners-Lee resisted the idea.

See also Lisa Larrimore Ouellette's 2015 discussion, "An Alternate History of the Web & Copyright Law," at http://writtendescription.blogspot.com/2016/02/an-alternate-history-of-web-copyright.html.

56 For example, for a description of the influence of telecommunications and electronics producers on discussions of Smart Grid standardization, see Contreras (2012).

57 A group of SDOs led by the IETF, W3C and the IEEE took a tentative step toward formalizing this ethos in 2012 with the publication of the OpenStand "Modern Paradigm for Standards" (see https://open-stand.org/about-us/principles/). The principles espoused by OpenStand include laudable ideals such as cooperation, due process, transparency and consensus. The OpenStand position regarding patents, however, does little other than accept both RF and FRAND licensing models for patented standards.

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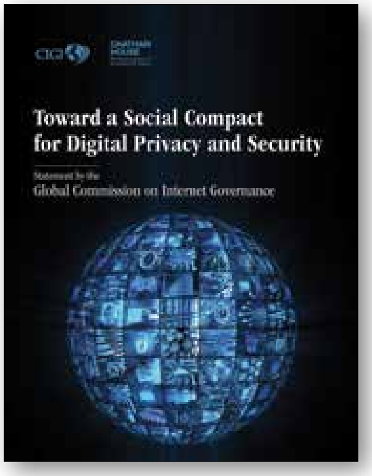

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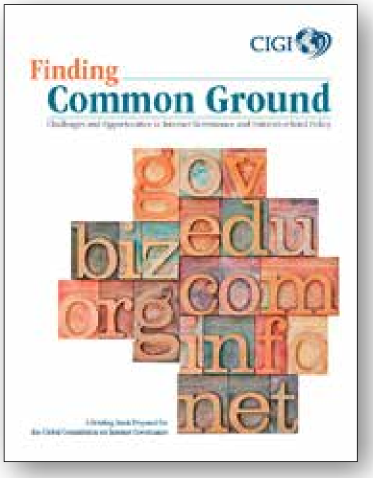

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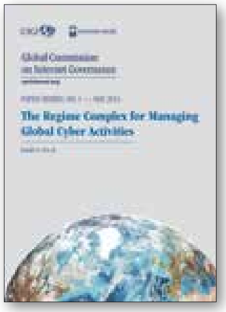

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