Vanderbilt Journal of Transnational Law

Volume 50
Issue 1 *January 2017*

Article 1

2017

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VANDERBILT JOURNAL
of TRANSNATIONAL LAW

VOLUME 50 JANUARY 2017 NUMBER 1

Patents and Mobile Devices in India: An Empirical Survey

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ABSTRACT

Though India has the second-largest wireless subscriber base in the world, with more than 150 domestic mobile device vendors, it has, until recently, remained relatively unaffected by the global smartphone wars. Over the past few years, however, a growing number of patent enforcement actions have been brought by multinational firms against domestic Indian producers. These actions, which have largely resulted in judgments favoring foreign patent holders, have given rise to a variety of proposals for addressing this situation.

In order to assess the potential impact of patents on the mobile device market in India, and to assist policy makers in formulating and implementing regulations affecting this market, we have conducted the first comprehensive academic study of the patent landscape of the mobile device sector in India. The results of this study illuminate a number of important features of the

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Indian mobile device market, including the overwhelming prevalence of foreign patent holders, the rate at which foreign and domestic firms are obtaining patents, and how these patent holdings are likely to shape industrial dynamics in the Indian market for mobile devices, as well as the availability of low-cost mobile devices that can significantly enhance public health, agriculture, safety, and economic development throughout India.

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I. INTRODUCTION

India has the second-largest mobile telephone subscriber base in the world, with nearly 1 billion wireless subscribers as of 2015.[1] Until recently, the Indian market for mobile handsets (including both feature phones and smartphones)[2] was dominated by multinational suppliers such as Samsung, Nokia, and Sony.[3] Over the past several years however, domestic Indian manufacturers have gained increasing market share, resulting in a market today with more than 150 different players.[4] The Indian firm Micromax rose from a 5.6 percent share of the Indian smartphone market in 2012 to an estimated 15 percent share in 2015, second only to Samsung, while Indian firms Intex and Lava rank third and fourth, respectively, in terms of market share.[5] These Indian firms, together with Chinese producers such as Lenovo and Xiaomi, have dominated the Indian market with a host of inexpensive units.

Many Indian smart phones are priced below $100, with a substantial number costing less than $40 or $50.[6] In February 2016, a

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1. TELECOM REGULATORY AUTHORITY OF INDIA, THE INDIAN TELECOM SERVICES PERFORMANCE INDICATORS JULY – SEPTEMBER 2015, at i (2016), http://www.trai.gov.in/WriteReadData/PIRReport/Documents/Indicator_Reports.pdf [https://perma.cc/S9U2-3XYJ] (archived Sept. 29, 2016) [hereinafter TRAI REPORT 2016] (reporting 996.66 million wireless subscriptions as of September 30, 2015).

2. *See Feature Phone*, TECHOPEDIA, https://www.techopedia.com/definition/26221/feature-phone (last visited Sept. 29, 2016) [https://perma.cc/4FDE-9TH6] (archived Sept. 29, 2016) ("A feature phone is a type of mobile phone that has more features than a standard cellphone but is not equivalent to a smartphone. Feature phones can make and receive calls, send text messages and provide some of the advanced features found on a smartphone."); *Smartphone*, TECHOPEDIA, https://www.techopedia.com/definition/2977/smartphone (last visited Sept. 29, 2016) [https://perma.cc/J5EG-ZUKY] (archived Sept. 29, 2016) ("A smartphone is a mobile phone with highly advanced features. A typical smartphone has a high-resolution touch screen display, WiFi connectivity, Web browsing capabilities, and the ability to accept sophisticated applications.").

3. Furquan Ameen Siddiqui, *Indian Smartphone Cos Challenging Big Players like Apple, Samsung,* HINDUSTAN TIMES (Oct. 6, 2013), http://www.hindustantimes.com/business/indian-smartphone-cos-challenging-big-players-like-apple-samsung/story-a09oU75tGLafR4EXiivIdJ.html [https://perma.cc/W57Z-BMRP] (archived Sept. 29, 2016).

4. *See India Surpasses USA to Become the Second Largest Smartphone Market in the World,* COUNTERPOINT TECH. MKT. RESEARCH (Feb. 2, 2016), http://www.counterpointresearch.com/press_release/indiahandsetmarket2015 [https://perma.cc/8B4F-2HDR] (archived Sept. 29, 2016) [hereinafter COUNTERPOINT 2015]; *India's Smartphone Market Soars in the Second Quarter of 2015 with the Help of eTailing, Says IDC*, INT'L DATA CORP. (IDC) (Aug. 11, 2015), http://www.idc.com/getdoc.jsp?containerId=prSG25827215 [https://perma.cc/EZS6-7CPG] (archived Sept. 29, 2016) [hereinafter IDC 2015 Report].

5. IDC 2015 Report, *supra* note 4.

6. *Gartner Says Global Smartphone Sales to Only Grow 7 Per Cent in 2016*, GARTNER, INC. (Mar. 31, 2016), http://www.gartner.com/newsroom/id/3270418 [https://perma.cc/8G4M-EGFP] (archived Sept. 29, 2016); *see Smartphone Prices Race to the Bottom as Emerging Markets Outside of China Come into the Spotlight for Future*

virtually unknown Indian firm called Ringing Bells made international headlines when it announced the launch of its new bare bones "Freedom 251" smart phone, retailing for a mere Rs. 251 ($4).[7] While there is skepticism about the viability of sub-$5 smartphones, and even the authenticity of Ringing Bells' offer,[8] sub-$50 price points are critical to the broad dissemination of mobile technology throughout India, where the average income is far below Western levels.[9]

Domestic Indian mobile devices also cater to the local market with local language apps and features.[10] The least expensive devices are often characterized by the use of previous-generation technology, such as 2G or 3G rather than 4G wireless connectivity and lower-resolution displays and cameras. However, Indian firms have shown remarkable ingenuity in differentiating their product offerings, both from one another and from international competitors. Local Indian devices, offered at less than $100, have included models with oversized speakers, virtual piano keyboards, pico-projectors, multiple charging ports, and/or multi-lingual capabilities.[11] This flourishing of local

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Growth According to IDC, IDC, (Feb. 24, 2012), https://www.idg.com/news/smartphone-prices-race-to-the-bottom-as-emerging-markets-outside-of-china-come-into-the-spotlight-for-future-growth-according-to-idc/ [https://perma.cc/YA27-X5HF] (archived Sept. 29, 2016) ("IDC research shows nearly half the mobile handsets sold across the world have retail prices of less than US$ 100 without sales tax. Two thirds of those have prices of less than US$ 50.").

7. Manu Balachandran & Itika Sharma Punit, *An Indian Company is Launching a $4 Smartphone*, QUARTZ INDIA (Feb. 17, 2016), http://qz.com/618235/an-indian-company-is-launching-a-4-smartphone/ [https://perma.cc/CQ4L-KM84] (archived Sept. 29, 2016) [hereinafter *$4 Smartphone*]. Several sources report that the Freedom 251 phone may be subsidized by the Indian government. *Id.* One source reports that the Freedom 251 is a rebranded version of China-manufactured Adcom Ikon 4 phone, which has a retail price of around Rs 4,000 in India. *See* Ankit Tuteja, *The Rs 251 SmartPhone Freedom 251 launched, but all is not well with this iPhone clone*, IBN LIVE (Feb. 17, 2016), http://www.ibnlive.com/news/tech/the-rs-251-smartphone-freedom-251-launched-but-all-is-not-well-with-this-iphone-clone-1204239.html [https://perma.cc/J4AZ-5CKJ] (archived Sept. 29, 2016) ("The phone also appears to be a rebranded version of another phone marketed in India by New Delhi-based Adcom.").

8. *See* Tuteja, *supra* note 7 ("There are also doubts about the sustainability of the price model . . . There's also speculation abound that the price could possibly be [sic] marketing gimmick.").

9. *See* IDC 2015 Report, *supra* note 4. According to figures published by the World Bank, gross national income per capita from 2011 to 2015 was US$ 1,590 in India, US$ 55,200 in the US, and US$ 47,640 in Germany. *GNI Per Capita, Atlas Method (Current US$)*, WORLD BANK, http://data.worldbank.org/indicator/NY.GNP.PCAP.CD/countries (last visited Sept. 29, 2016) [https://perma.cc/TN26-MRB3] (archived Sept. 29, 2016).

10. The Freedom 251, for example, is advertised as including preinstalled apps relating to pet projects of the Modi administration, including women's safety and the "Swachh Bharat" anti-litter initiative. *$4 Smartphone*, *supra* note 7.

11. *See, e.g.*, *Lava Launches Mobile Phone with 22 Indian Languages Support, pricing at Rs1500*, UNITED NEWS INDIA (Mar. 30, 2016), http://www.uniindia.com/lava-launches-mobile-phone-with-22-indian-languages-support-pricing-at-rs-1500/electronics-gizmos/news/430615.html [https://perma.cc/39YQ-AUWU] (archived Sept. 29, 2016) (describing the features of a new phone retailing for Rs 1500); Jorge L.

innovation is remarkable and is encouraged, as this Article argues, by low entry barriers.[12]

In the developed world, the mobile device industry has been embroiled in patent infringement litigation for nearly a decade.[13] Multinational players such as Apple, Samsung, Google/Motorola, and Microsoft hold thousands of patents covering mobile devices and technology.[14] Patents in the mobile industry are held not only by handset manufacturers, but also by technology developers such as Qualcomm, Alcatel-Lucent, Broadcom, Texas Instruments, and Intel, wireless carriers such as AT&T, Sprint, Verizon, and NTT DoCoMo, and patent assertion entities, which may hold fewer patents but act more aggressively in asserting them.[15]

But, despite many years of relatively little patent litigation in the Indian telecommunication sector, there are signs that the attention of global patent holders has been drawn to this market. One 2010 study found that the vast majority of telecommunications-related patents in India are held by non-Indian firms.[16] And, over the past few years, multinational telecommunications giant Ericsson has brought patent infringement suits against several Indian and Chinese handset vendors serving the domestic Indian market. Industry experts have expressed concern that litigation by multinational patent holders against small Indian vendors could adversely affect recent national initiatives to foster a domestic Indian high-technology sector.[17]

Contreras, *Patent-Less Smartphone Innovation and Global Technology Markets*, PATENT PROGRESS (Dec. 19, 2012), http://www.patentprogress.org/2012/12/19/patent-less-smartphone-innovation-and-global-technology-markets/#more-1356 [https://perma.cc/L8TU-LZJN] (archived Sept. 29, 2016) (summarizing the features of various smartphones on the market).

12. These could include, for example, lower patent costs arising from a lack of issued patents in fields such as computer software, a lack of royalty payment associated with issued patents, or liberal laws permitting reverse engineering of devices.

13. *See, e.g.*, Jorge L. Contreras, *The Frand Wars: Who's on First*, PATENTLY-O BLOG (Apr. 17, 2012), http://patentlyo.com/patent/2012/04/the-frand-wars-whos-on-first.html [https://perma.cc/74DE-7HUY] (archived Sept. 29, 2016) (discussing the development of multiple patent lawsuits filed since 2010).

14. *See* THE IMPACT OF THE ACQUISITION AND USE OF PATENTS ON THE SMARTPHONE INDUSTRY, CENTER ON LAW AND INFORMATION POLICY AT FORDHAM LAW SCHOOL (CLIP) IV-2, (Dec. 13, 2012), http://www.wipo.int/export/sites/www/ip-competition/en/studies/clip_study.pdf [https://perma.cc/ARD3-QDU5] (archived Sept. 29, 2016) [hereinafter CLIP 2012 Study] (surveying the current smartphone patent market and major companies therein).

15. *Id.* at 38. *See also* Jorge L. Contreras, *Assertion of Standard Essential Patents by Non-Practicing Entities*, *in* PATENT ASSERTION ENTITIES AND COMPETITION POLICY 50 (D. Daniel Sokol, ed.) (2017) (detailing the rate at which non-practicing entities asserted patents covering technology standards relative to others).

16. CLAIRVOLEX, INC., INDIA'S PATENT LANDSCAPE IN COMMUNICATION TECHNOLOGY (2010), http://www.clairvolex.com/pdf/communication.pdf [https://perma.cc/4GTM-BQBQ] (archived Sept. 30, 2016).

17. Soma Das & Anandita Singh Mankotia, *Patent Row: Delhi High Court Asks Micromax to Pay Royalty to Ericsson*, ECON. TIMES (Nov. 20, 2014), http://articles.economictimes.indiatimes.com/2014-11-20/news/56304154_1_several-

In order to assess the potential impact of patents on the mobile device market in India, and to assist policy makers in formulating and implementing regulations affecting this market, we conducted a comprehensive patent landscape analysis of the mobile device sector in India. The study involved the collection and analysis of data relating to Indian patent ownership by technology type, nationality, and industry classification. These results illuminate a number of important features of the Indian market for mobile devices, including the overwhelming prevalence of foreign patent holders in India, the rate at which foreign and domestic firms are obtaining patents, and how these patent holdings are likely to shape industrial dynamics in the Indian market for mobile devices.

The remainder of this Article proceeds in three parts. Part II provides a brief history of the telecommunications market in India, charting the influence of foreign manufacturers and carriers on the market. Part II also includes a discussion of a range of humanitarian, public health, and agricultural uses of mobile technologies in India and other developing countries. Part III(A) provides an overview of the Indian patent system, focusing on its evolution in response to international pressures. Part III(B) discusses recent Indian patent infringement and competition litigation in the telecommunications sector. Part IV presents the results of the patent landscape study of the Indian mobile device market. Part V concludes with recommendations for further study and policy.

II. OVERVIEW OF THE INDIAN MOBILE TELECOMMUNICATIONS MARKET

A. *Indian Telecommunications Regulation and Wireless Market Evolution*

The telecommunications market in India has been characterized by a gradual shift from significant governmental regulation and control toward open market competition. This shift has both enabled competition among Indian service providers and carriers and fostered the opening of India's telecommunications equipment markets to foreign competitors.

1. Early Telecommunication Market Regulation

Following its independence, India established governmental monopolies in a number of industries, including telecommunications.[18] Foreign telecommunication firms were put under the control of the

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wireless-technology-standards-low-cost-business-strategy-digital-india [https://perma.cc/NU7D-2FVV] (archived Sept. 30, 2016).

18. Ramesh Subramanian, *The Continuing Evolution of India's Telecom Policy*, 8 COMMS. OF THE IIMA 33, 35 (2008).

Posts and Telegraphs Department (P&T), a state-run monopoly,[19] and other private firms were prohibited from entering the market.[20] During the last half of the twentieth century, the Indian government invested only minimal amounts in its telecommunications infrastructure, severely limiting the quality, quantity, and range of available services.[21]

By the early 1980s, policy makers began to realize that India's protective industrial system and heavy regulation had resulted in stagnation and inefficiency.[22] In the mid-1980s, the Indian government took a first step toward liberalizing the telecommunications sector by allowing private firms to manufacture network terminal and switching equipment.[23] Around the same time, the Indian government also began to loosen import restrictions on electronics, computers, and telecommunications equipment.[24]

In the early 1990s, India experienced a severe economic crisis brought on by a combination of rising petroleum costs and the general global recession of 1991.[25] India's foreign exchange reserves were severely depleted and the rupee fell dramatically in value.[26] To counter the effects of the economic downturn, the Indian government made several economic reforms, including partial liberation of the financial sector and gradual opening of the Indian market to foreign firms.[27] The resulting economic liberalization enabled private sector players to enter India's telecommunications market, boosting not only private investment and competition but also India's telecommunications infrastructure.[28]

Further changes to India's telecommunications sector were made in 1994 under the National Telecom Policy (NTP).[29] The NTP gave India's Department of Telecommunications (DoT) control over India's profitable long distance and international services.[30] Private firms were allowed access only to the local loop, which required significant capital investments in fiber-optic cable.[31] Nevertheless, private firms

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19. *Id.*
20. *Id.*
21. William Greene, *The Liberalization of India's Telecommunications Sector: Implications for Trade and Investment* 8 (U.S. Int'l Trade Comm'n, Working Paper No. 2004-09-B, 2004).
22. Subramanian, *supra* note 18.
23. Greene, *supra* note 21.
24. *Id.*
25. Arunabha Ghosh, *Pathways Through Financial Crisis: India*, 12 GLOBAL GOVERNANCE 413, 413–29 (2006).
26. Valeria Cerra & Shweta Chaman Saxena, *What Caused the 1991 Currency Crisis in India?* 49 IMF STAFF PAPERS 395, 395 (2002).
27. Ghosh, *supra* note 25, at 416.
28. Greene, *supra* note 21, at 8.
29. *See* IBP USA, INDIA TELECOM LAWS AND REGULATIONS HANDBOOK 50 (Colin Blackman and Lara Srivastava eds., 2009).
30. Subramanian, *supra* note 18, at 38.
31. *Id.*

were permitted to compete for other telecommunication services after meeting their obligations to the local loop arena.[32]

2. Mobile Services

Around this time, mobile telecommunication services in India were commercially launched.[33] In 1997, the Indian government established the Telecommunications Regulatory Authority of India (TRAI), an independent agency authorized to manage and regulate Indian telecommunications.[34] The mission of TRAI was to "create and nurture conditions for growth of telecommunications in the country in a manner and at a pace which w[ould] enable India to play a leading role in emerging global information society."[35]

In 1999, India adopted a New Telecom Policy (NTP 1999).[36] The NTP 1999's objectives included increasing public access to telecommunications services, providing affordable and effective communications for Indian citizens, encouraging the development of telecommunications in rural areas, making the telecommunications sector more competitive, and enabling Indian companies to become global competitors.[37] The NTP 1999 also included a number of specific targets relating to user base, access, and density.[38] To achieve NTP 1999's ambitious goals, India's telecommunication regulations were amended to encourage private firms to enter the market.[39]

In 2000, the Indian government enacted the TRAI Amendment Act of 2000 in a further effort to revive India's stalled telecommunications sector.[40] The amendments explicitly defined TRAI's role in areas such as wireless communications, quality standards, tariffs, and interconnection.[41] The Indian government also

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32. *Id.*

33. IBP USA, *supra* note 29, at 51.

34. *Id.* at 39. The TRAI can make recommendations to the DoT in areas specified under "Functions of Authority" in Article X of the TRAI Act of 1997.

35. *History*, TELECOM REGULATORY AUTH. OF INDIA, http://www.trai.gov.in/Content/History.aspx (last visited Sept. 30, 2016) [https://perma.cc/Y8ZA-SQGA] (archived Sept. 30, 2016).

36. *Id.*

37. *New Telecom Policy*, TELECOM REGULATORY AUTHORITY OF INDIA, http://www.trai.gov.in/Content/ntp_1999.aspx (last visited Mar. 5, 2015) [https://perma.cc/Y8ZA-SQGA] (archived Sept. 30, 2016).

38. *Id.* The target goals of the NTP 1999 were, in part, to make telephone available on demand by 2002, to achieve a teledensity of 7 percent by 2005 and 15 percent by 2010, to increase rural teledensity from .04 percent to 4 percent by 2010, to achieve telecom coverage of all villages in the country by 2002, to provide Internet access to all district headquarters by 2000, and to provide high speed data and multimedia capability by 2002 in all towns with a population greater than 2 million.

39. Subramanian, *supra* note 18, at 39.

40. *TRAI (Amendment) Act 2000*, TELECOM REGULATORY AUTHORITY OF INDIA, http://www.trai.gov.in/Content/Act2001.aspx (last visited Sept. 30, 2016) [https://perma.cc/83W7-4L9Q] (archived Sept. 30, 2016).

41. *Id.*

took steps to open the wireless market to private competition. Prior to this time, the Indian government capped foreign ownership of telecommunications providers at 49 percent. But, in March 2000, the government reduced license fees for mobile service providers and increased the allowable stake for foreign companies to 74 percent.[42]

The most significant changes effected by NTP 1999 and the 2000 amendments were in the area of carrier tariffs.[43] First, operators shifted from having to pay up-front auction fees to having to pay through a revenue sharing system.[44] However, the revenue sharing percentage was initially set too high, so the beneficial effects became apparent only after it was reduced from 15 percent to 8 percent.[45] NTP 1999 specified that the TRAI would recommend a tariff ceiling, and the resultant TRAI order reduced cellular tariffs per minute from Rs. 16 to Rs. 6.[46] A second development affecting tariffs was the introduction of unregulated CDMA (code division multiple access) technology by private and public sector operators and the ensuing price competition.[47] A third factor was a TRAI order in May 2003 concerning Calling Party Pays, which reduced tariffs by half.[48]

Together, these changes dramatically reduced the cost of wireless service and mobile phones, enabling large numbers of middle class families to afford mobile services for the first time.[49] This increased affordability, along with factors such as expanding wireless coverage throughout India, increasing per capita income, and falling call tariffs, likely contributed to the increase in India's mobile subscriber base after 2002. In 2002, the total number of mobile subscribers in India was approximately 10.5 million; from 2003 to 2005, the number of monthly mobile subscribers increased by about 2 million subscribers per month.[50] By 2006, India had 65 million mobile subscribers.[51]

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42. IBP USA, *supra* note 29, at 51.

43. Shyam Ponappa, *Take 'Model T' for Telecom*, BUS. STANDARD (Dec. 2, 2010), http://www.business-standard.com/article/opinion/shyam-ponappa-take-model-t-for-telecom-110120200051_1.htmlX [https://perma.cc/7LMH-6DPE] (archived Sept. 30, 2016).

44. HARSHA VARDHANA SINGH, ANITA SONI & RAJAT KATHURIA, TELECOM POLICY REFORM IN INDIA 7 (2000), http://siteresources.worldbank.org/INTRANETTRADE/Resources/Singh.pdf [https://perma.cc/WZC4-54F6] (archived Sept. 30, 2016).

45. *Id.* at x.

46. *Id.* at 15.

47. *See generally CDMA In India – Past, Present and Future*, TELECOMTALK.INFO (Nov. 24, 2014), https://telecomtalk.info/cdma-in-india-past-present-and-future/50370/ [https://perma.cc/C27N-62MW] (archived Oct. 25, 2016) (describing the timeline of CDMA technology in India).

48. TELECOMM. REGULATORY AUTHORITY OF INDIA, CONSULTATION PAPER ON REVIEW OF INTERCONNECTION USAGE CHARGES 6 (2011) http://www.trai.gov.in/WriteReaddata/ConsultationPaper/Document/cp-27apr2011.pdf [https://perma.cc/B3ZR-DQKW] (archived Oct. 3, 2016).

49. IBP USA, *supra* note 29, at 51.

50. *Id.*

51. *Id.*

Further changes to India's mobile market occurred in 2007, when private cellular service providers persuaded the DoT to release unused wireless spectrum from the Indian military.[52] The unused spectrum was assigned to firms based on number of subscribers. Licenses were to be made available on a first-come-first-served basis.[53] The increase in available spectrum resulted in greater competition and market penetration of mobile services throughout the country. By 2008, the total number of mobile subscribers in India reached 246 million, and India's mobile subscriber base has continued to grow since 2008.[54] By September 2015, India had 997 million wireless subscribers, making it the world's second largest wireless market, after China.[55] Alongside mobile subscriber growth, handset sales and mobile Internet usage have also increased substantially.[56]

B. *Characteristics of the Indian Mobile Sector*

India has historically lacked reliable and widespread landline telephone infrastructure throughout large portions of its territory.[57] As a result, mobile services, which involve lower per line costs, quick deployment, and reduced capital requirements, have surpassed landline telecommunications services in India by a significant degree.[58] Thus, in September 2015, India had approximately 997 million wireless subscribers, but only 26 million landline subscribers.[59] And, among rural subscribers, approximately 5 million had landlines, while 419 million had wireless service.[60] Similarly, the majority of Internet users in India access the Internet via mobile devices, while only 5 percent own personal computers.[61]

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52. *See generally* T.V. RAMACHANDRAN, RADIO RESOURCE MANAGEMENT IN HIGHLY POPULATED DEVELOPING COUNTRIES (2008) http://www.itu.int/osg/spu/stn/spectrum/spectrum_resources/general_resources/Ramachandran_URSI.pdf [https://perma.cc/8Z3L-EES7] (archived Oct. 3, 2016).

53. *Id.*; *see also* COMPTROLLER AND AUDITOR GEN. OF INDIA, PERFORMANCE AUDIT REPORT ON THE ISSUE OF LICENSES AND ALLOCATION OF SPECTRUM BY THE DEPARTMENT OF TELECOMMUNICATIONS 24 (2010) http://www.cag.gov.in/sites/default/files/audit_report_files/Union_Performance_Civil_Allocation_2G_Spectrum_19_2010.pdf [https://perma.cc/SH7Y-2LVC] (archived Oct. 3, 2016).

54. Subramanian, *supra* note 18, at 42.

55. TRAI REPORT 2016, *supra* note 1.

56. IPSOS BUS. CONSULTING, INDIA'S MOBILE PHONE MARKET 3 (2014) http://www.ipsosconsulting.com/pdf/Research-Note-India-Mobile-Phone-Market.pdf [https://perma.cc/VTJ8-DGM3] (archived Oct. 10, 2016).

57. P. Jain & V. Sridhar, *Analysis of Competition and Market Structure of Basic Telecommunication Services in India*, 52 COMMS. & STRATEGIES 271, 275 (2003).

58. *Id.* at 26; *see also* Raghbendra Jha & Sumit Majumda, *A Matter of Connections: OECD Telecommunications Sector Productivity and the Role of Cellular Technology Diffusion*, 11 INFO. ECON. & POL'Y 243, 243 (1999).

59. TRAI REPORT 2016, *supra* note 1.

60. *Id.*

61. BOSTON CONSULTING GROUP, THE MOBILE REVOLUTION: HOW MOBILE TECHNOLOGIES DRIVE A TRILLION DOLLAR IMPACT 15 (2015).

After 1994, several foreign telecommunications operators such as AT&T, Bell Canada, British Telecom, Swiss Telecom, US West, and Hutchison, entered into joint ventures with Indian companies to set up operations, and later sold out their shares to domestic carriers.[62] The consumer handset market was initially dominated by multinational suppliers such as Samsung, Nokia, and Sony.[63] It has only been over the past decade that domestic Indian handset manufacturers have gained increasing market share.[64] The Indian mobile handset market today consists of more than 150 competitors including South Korean firm Samsung, Indian firms such as Micromax, Intex, and Lava, and Chinese firms such as Lenovo and Xiaomi.[65] Indian and Chinese producers have generally dominated the low-cost segment of the Indian market with a variety of sub-$100 phones targeted at price-sensitive Indian consumers.

Though there is a large and growing number of domestic Indian mobile device vendors, few, if any, manufacture their products in India.[66] Instead, most Indian handset vendors source hardware from assemblers and contract manufacturers located in countries such as China, Taiwan, and Thailand, then load them with India-specific applications and package them for distribution and marketing in the Indian market.[67] Such low-cost devices typically run the Android open source operating system, utilize low-end hardware, are equipped with prior-generation capabilities (e.g., 2G rather than 3G or 4G wireless connectivity), and come with little if any customer support. Nevertheless, there is a pressing demand for such low-cost devices throughout both urban and rural areas.

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62. *See, e.g.*, John Ure & Araya Vivorakij, *Telecommunications and Privatisation in Asia*, *in* BUSINESS, MARKETS AND GOVERNMENT IN THE ASIA-PACIFIC 237, 260 (Yun-Peng Chu & Rong-I Wu, eds., 1998) (providing a list of Indian-American partnerships); Press Release, Hutchison Telecom, Hutchinson Telecom to Sell India Business to Vodafone 1 (Feb. 12, 2007) (http://www.ckh.com.hk/upload/attachments/en/pr/1875_eng.pdf [https://perma.cc/7YLM-99RA] (archived Oct. 3, 2016)) (announcing transaction between Hutchinson Telecom and Vodafone regarding Indian coverage); Manan Kakkar, *AT&T Makes Another Attempt to Enter India*, ZDNET (Mar. 12, 2013) http://www.zdnet.com/article/at-t-makes-another-attempt-to-enter-india/ [https://perma.cc/5KEY-MN5B] (archived Oct. 10, 2016) (discussing AT&T's investments in Indian telecommunications).

63. Siddiqui, *supra* note 3.

64. *See* COUNTERPOINT 2015, *supra* note 4 (showing the market shares of Indian manufacturers); IDC 2015 Report, *supra* note 4 (highlighting recent growth of smartphone vendors).

65. IDC 2015 Report, *supra* note 4.

66. *See* DIETER ERNST, EAST-WEST CENTER SPECIAL STUDY, UPGRADING INDIA'S ELECTRONICS MANUFACTURING INDUSTRY: REGULATORY REFORM AND INDUSTRIAL POLICY 3 (2014), http://www.eastwestcenter.org/sites/default/files/private/ernst-ugradingindia.pdf [https://perma.cc/Y4Y6-UHM6] (archived Oct. 3, 2016) (discussing India's historical and current lack of advanced manufacturing capability).

67. *Id.*

C. *Applications of Mobile Technology in India*

In the United States and other developed markets, smartphones and other mobile devices are typically viewed as tools for productivity enhancement and personal entertainment. But in developing nations access to mobile technology can serve a number of important social functions including the improvement of health, education, economic development, and public welfare.[68] For example, mobile communication enables the rapid sharing and coordination of information concerning weather, crop conditions, disease outbreaks, natural disasters, armed conflicts, emergency response, infrastructure (e.g., roads, irrigation systems, and power lines), and the availability of medical aid and disaster relief.[69] Mobile communication also enables access to educational materials and government resources and supports the maintenance of familial and social networks.[70] Access to healthcare information and resources can significantly improve health monitoring, patient counseling, and follow-up.[71] The capabilities of mobile devices also enable a wide range of commercial activities, from simple online purchasing to comparison shopping, job searching, banking, funds transfer, micro-lending, inventory management, and tax collection.[72] For example, in India, Flipkart—the app of a popular online marketplace—enables Indian residents to shop and compare goods from thousands of vendors.[73]

These functions and capabilities are particularly important in countries like India that lack a pervasive and resilient wired telecommunications infrastructure. Economist Jeffrey Sachs has referred to mobile technology as "the greatest tool for poverty alleviation ever invented,"[74] and, at a macroeconomic level, one

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68. *See* Alfredo Herrera & Thomas Prowse, *IEEE's Humanitarian Open Source: A Path to Open Standards and Interoperability*, *in* PROCEEDINGS OF THE THE 9TH INTERNATIONAL CONFERENCE ON STANDARDIZATION AND INNOVATION IN INFORMATION TECHNOLOGY (IEEE SIIT) 1 (2015); YONGSOO KIM, TIM KELLY & SIDDHARTHA RAJA, THE WORLD BANK, BUILDING BROADBAND: STRATEGIES AND POLICIES FOR THE DEVELOPING WORLD 2 (2010); Jenny C. Aker & Isaac M. Mbiti, *Mobile Phones and Economic Development in Africa*, 24 J. ECON. PERSP. 207, 207–08 (2010); Ahmed T. Rashid & Laurent Elder, *Mobile Phones and Development: An Analysis of IDRC-Supported Projects*, 36 ELEC. J. INFO. SYS. DEV. COUNTRIES 1, 2–3 (2009).

69. *See* Debanjan Das Deb et al., *Coordinating Disaster Relief Operations Using Smartphone/PDA Based Peer to Peer Communication*, 4 INT'L J. WIRELESS & MOBILE NETWORKS 27, 27 (2012).

70. Rashid & Elder, *supra* note 68, at 2–4.

71. Anita Shet & Ayesha de Costa, *India Calling: Harnessing the Promise of Mobile Phones for HIV Healthcare*, 16 TROPICAL MED. & INT'L HEALTH 214, 214 (2010).

72. Harald Gruber & Pantelis Koutroumpis, *Mobile Telecommunications and the Impact on Economic Development*, 26 ECON. POL'Y 387, 392 (2011).

73. BOSTON CONSULTING GROUP, *supra* note 61, at 15; *See also* Rohini Lakshané, *The WhatsApp Economy* (Feb. 27, 2016), http://www.slideshare.net/CIS_India/rohini-lakshan-the-whatsapp-economy-27022016 [https://perma.cc/EM2R-AKAT] (archived Oct. 10, 2016).

74. BOSTON CONSULTING GROUP, *supra* note 61, at 20.

comprehensive international study found that mobile penetration has a direct impact on GDP growth.[75] This Section surveys some of the important social applications of mobile technology in India and other developing countries.

1. Healthcare

Mobile technology has increasingly been used to advance healthcare, particularly in remote and underserved regions.[76] Some of these advances include medical appointment reminders, telemedicine, patient record access, treatment compliance measurement, health awareness, patient monitoring, and physician decision support.[77]

With the dramatic increase in mobile phone subscribers in India, the Indian government has also taken steps to integrate and enhance health-related IT systems.[78] For example, the Ministry of Health and Family Welfare has created a Mother and Child Tracking System (MCTS), which uses information technology to deliver health care information and services to pregnant women and mothers of children up to five years old.[79] MCTS uses a data bank to validate delivery of services, ensure ante-natal, intra-natal, and post-natal checkups, encourage immunizations, and promote quality service delivery.[80] Pregnant mothers enrolled in the system can use MCTS to track what scheduled services they have received and what maternal care services they still require.[81]

In addition to MCTS, the Indian government is planning a mobile-based information dissemination initiative to distribute health promotion messages about maternal and child health, nutrition, adolescent health, population stabilization, tobacco control, and disease information.[82]

2. Agriculture

Mobile technology advances have contributed significantly to India's agricultural sector, one of the most important segments of the Indian economy.[83] Mobile phones are being used to convey weather

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75. *Id.*

76. Darrell West, *How Mobile Devices Are Transforming Healthcare*, ISSUES IN TECH. INNOVATION, May 2012, at 1.

77. *Id.*

78. Press Release, Gov't of India Ministry of Health & Family Welfare, India is the Second-Largest Mobile Phone User in the World (Aug. 2, 2012) (on file with author).

79. *Id.*

80. *Id.*

81. *Id.*

82. *Id.*

83. SARAVANAN RAJ & SUCHIRADIPTA BHATTACHARJEE, MOBILE PHONES FOR AGRICULTURAL EXTENSION: WORLDWIDE MAGRI INNOVATIONS & PROMISE FOR FUTURE 3 (2014).

information, to coordinate pest and disease control efforts, to disseminate market information relating to fertilizers, seeds, and crops, and to enable communication among workers and families in the field. [84]

India's Department of Agriculture and Cooperation and Ministry of Agriculture have launched "Farmer Call Centres" across the country that track agricultural issues and allow farmers to receive updated information via phone.[85] Further, the Indian Council of Agricultural Research has set up mobile advisory services that allow "Farm Science Centres" to send SMS text alerts to farmers relating to weather forecasts, crop diseases, and market conditions.[86] One farmer reportedly estimated that he increased his annual earnings by 25 percent "thanks to the farming and disease control techniques he learned from the service's regular messages."[87] Another farmer reported that he doubled his tomato yield by using the mKrishi mobile agriculture data app on his phone.[88]

Various other technologies have been developed to assist farmers in India. One such device is a phone-controlled water pump called a "Nano Ganesh."[89] The Nano Ganesh, which is relatively inexpensive, connects a farmer's mobile phone to his water pump.[90] The farmer can enter a code to start the water pump, even without regular cell phone service.[91] There is also a service called "Tata" that allows farmers to send photos of diseased crops to experts directly from their phones and receive feedback regarding appropriate remedial measures.[92] Another app, called "Tradersnet," is a virtual commodity exchange that connects producers and wholesale purchasers of coffee.[93] The app sends SMS messages to users' mobile phones every morning with offers and the grades available for purchase that day. At the end of the day, users receive a text message with details of transactions completed.[94]

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84. Prashanthi Bonthu, India and China: A Comparative Analysis of Mobile Phones in Agriculture 2 (Feb. 3, 2014) (unpublished M.A. thesis, University of Kansas) https://kuscholarworks.ku.edu/bitstream/handle/1808/14544/Bonthu_ku_0099M_13245_DATA_1.pdf;jsessionid=C30D48F0A4F766ABD5157FF26A280C14?sequence=1 [https://perma.cc/S255-ZNL5] (archived Oct. 3, 2016).

85. RAJ & BHATTACHARJEE, *supra* note 83, at 6–7.

86. *Id.* at 8.

87. Niraj Chokshi, *How Mobile Phones Are Transforming Indian Agriculture*, ATLANTIC (Aug. 12, 2010), http://www.theatlantic.com/technology/archive/2010/08/how-mobile-phones-are-transforming-indian-agriculture/61394/ [https://perma.cc/W9KJ-P9KF] (archived Oct. 10, 2016).

88. BOSTON CONSULTING GROUP, *supra* note 61, at 20.

89. Chokshi, *supra* note 87.

90. *Id.*

91. *Id.*

92. *Id.*

93. *Id.*

94. *Id.*

3. Personal Safety

A number of personal safety apps have been launched in India in response to highly publicized incidents of violence against women.[95] One such app instantly sends the following message to pre-loaded contacts when the user activates it: "I am in danger. I need help. Please follow my location," along with details of the sender's whereabouts.[96]

The Indian government has also taken steps to enhance personal safety through mobile devices. It recently launched a safety app called "Himmat" in the Delhi market. The app automatically alerts police and begins audio and video recording when the user signals that she is in distress.[97] Similar apps have been introduced in other Indian cities. In addition to personal safety apps like these, India's Ministry of Finance has approved proposals to streamline police, mobile, and legal services in India.

4. Disaster Response and Relief

Mobile technology has also increasingly been used to improve the efficacy of disaster response and humanitarian aid in India and around the world.[98] For example, during severe flooding in Chenai in 2015, relief efforts were coordinated via Twitter and Facebook.[99] Crowdsourcing was used to map flooded roads and relief sites, and to channel relief and rescue efforts to the most critical areas.[100] As one relief worker commented, "the Internet is our lifeline now."[101] Similar efforts helped to locate stranded persons and improve crisis response

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95. Sujoy Dhar, *Women's Safety Schemes Go Mobile in India*, INTER PRESS SERV. (May 13, 2015), http://www.ipsnews.net/2014/11/womens-safety-schemes-go-mobile-in-india/ [https://perma.cc/5NBH-5TY6] (archived Oct. 10, 2016); *see also Fifteen Personal Safety Apps for Women*, TIMES OF INDIA (Dec. 9, 2014), http://timesofindia.indiatimes.com/tech/slideshow/15-personal-safety-apps-for-women/itslideshowviewall/45431568.cms [https://perma.cc/X3JN-8UHW] (archived Oct. 10, 2016).

96. *Id.*

97. *Government Launches Integrated Women Safety Mobile App Himmat*, INDIA TODAY (Jan. 3, 2015), http://indiatoday.intoday.in/education/story/government-launches-integrated-women-safety-mobile-app-himmat/1/411183.html [https://perma.cc/PH29-GJ9T] (archived Oct. 2, 2016).

98. Darrell M. West & Elizabeth Valentini, *How Mobile Devices are Transforming Disaster Relief and Public Safety*, ISSUES IN TECH. INNOVATION, July 2013, at 1.

99. Raveena Joseph & Apoorva Sripathi, *Help Pours in Via Social Media*, THE HINDU (Dec. 5, 2015), http://www.thehindu.com/features/metroplus/society/chennai-floods-help-pours-in-via-social-media/article7945550.ece [https://perma.cc/UUQ2-ZWDE] (archived Oct. 2, 2016).

100. *Id.*

101. *Id.*

during flooding in Uttarakhand in 2013.[102] A decade earlier, when a tsunami hit the eastern coast of India killing one hundred thousand people, volunteers from IEEE, a major global trade association and standards-development organization, helped to restore communications, logistics, and emergency coordination in the devastated region.[103]

To support such initiatives, researchers in Australia have developed software that enables communication between mobile devices in areas where there is no reception by combining voice-over-IP technology with Wi-Fi.[104] This technology enables communication during natural disasters when traditional communication networks have been disabled.[105] Service providers have contributed as well: for example, AT&T has launched a public safety challenge that encourages mobile app developers to submit ideas for improving emergency services' response to disasters.[106] Similarly, Qualcomm and Sesame Workshop have launched a mobile safety program in China that uses mobile devices to help young children and their families learn how to deal with emergency situations.[107] Apple has a new section in its App Store called "Stay in Touch," which provides several disaster-relief applications: The American Heart Associations' *Pocket First Aid & CPR*; *QuakeWatch*, which tracks earthquakes and sends warnings using U.S. Geological Survey data; *Disaster Alert*, which provides information on instant global "active hazards"; the American Red Cross's *Shelter View*, which helps users locate a nearby shelter; and *Emergency Radio*, which provides news and information during disasters.[108]

All of these social, coordination, and humanitarian uses of mobile technology are particularly important in developing countries such as India, which lack legacy landline communication infrastructures. But such technologies are not developed or deployed in a legal or policy vacuum. The next Part discusses the patent system as it exists in India, and how it affects the development of new mobile technologies.

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102. *See 2013 Uttarakhand Flooding*, GOOGLE CRISIS RESPONSE (2013), http://google.org/crisismap/2013-uttrakhand-floods?gl=in [https://perma.cc/D7NF-BWR5] (archived Oct. 2, 2016).

103. Herrera & Prowse, *supra* note 68, at 2.

104. West & Valentini, *supra* note 98, at 2–3.

105. *Id.* at 3.

106. *Id.*

107. *Id.*

108. *Id.* at 4.

III. THE INDIAN PATENT SYSTEM

A. *Overview of the Indian Patent System*

1. Legal and Administrative Background

India's first patent act was enacted in 1856, modeled on then-prevailing English law.[109] As such, India offered relatively strong patent protection for domestic and foreign products.[110] In 1970, however, India radically amended its Patent Act, substantially limiting the availability of patents on several product categories, but continuing to protect the processes used to make them.[111]

The Indian Patent Office (IPO) has administrative authority to examine and grant patents in India. The IPO is an office within the Department of Industrial Policy and Promotion (DIPP), which is itself a department within the Ministry of Commerce and Industry.[112] Oversight of the IPO is delegated by DIPP to the Controller General of Patents, Designs and Trade Marks.[113] Despite statutory requirements concerning prompt action on patent applications, the IPO has been criticized recently for the excessive amount of time often required for patent examination in India. Some reports suggest that it takes eight to nine years from application to issuance of a patent,[114] but the IPO has begun to consider various administrative reforms to address this problem.[115]

For historical, cultural, and political reasons, India has generally adopted an abstemious posture toward patent protection. For example, India did not recognize patents on pharmaceutical products or processes until 2005[116] and still declines to issue patents on software

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109. KALYAN C. KANKANALA ET AL., INDIAN PATENT LAW & PRACTICE 1 (2010).

110. P. NARAYANAN, PATENT LAW 5 (2006). *See also* SRIVIDHYA RAGAVAN, PATENT AND TRADE DISPARITIES IN DEVELOPING COUNTRIES 31–32 (2016) (summarizing the history of Indian patent law).

111. The Patents Act, No. 39 of 1970, INDIA CODE (1970) [hereinafter Patents Act]. *See* RAGAVAN, *supra* note 110, at 42–45 (summarizing changes effected by the 1970 law).

112. KANKANALA ET AL., *supra* note 109, at 8.

113. *Id.*

114. *See, e.g.*, Pravin Anand, *Dealing with Patent Delays*, WORLD INTELL. PROP. REV. (May 1, 2015), http://www.worldipreview.com/contributed-article/patent-delays-dealing-with-delays [https://perma.cc/H4YJ-YD9N] (archived Oct. 10, 2016); Madjur Singh, *Slow Processes for IP Rights Worry Businesses in India*, Pat. Trademark & Copyright J. (BNA) (Nov. 18, 2016).

115. *See, e.g.*, K.L. Vahehra & Sharad Vadehra, *Overcoming Delays and Inconsistency at the Indian Patent Office*, MANAGING INTELL. PROP. (Sept. 4, 2015), http://www.managingip.com/Article/3485795/Overcoming-delays-and-inconsistency-at-the-Indian-Patent-Office.html [https://perma.cc/PBH5-VHH4] (archived Oct. 2, 2016) (discussing administrative reforms); Madhur Singh, *India Aims to Decide Patent Applications in 18 Months*, Pat. Trademark & Copyright J. (BNA) (Apr. 27, 2016) (discussing hiring more examiners to address time issues).

116. KANKANALA ET AL., *supra* note 109, at 2.

inventions.[117] Nevertheless, India has issued a sizeable number of patents, with nearly 50,000 patents in force as of 2014, making it 22nd in the world.[118]

As a member of the World Trade Organization (WTO) since 1995, India is a party to the WTO Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS).[119] As such, India is required to implement certain minimum standards of patent protection in its national law. While India's Patent Act amendments of 1999, 2002, and 2005 were intended to bring India's patent law into compliance with TRIPS, there is still controversy regarding India's implementation of these statutory requirements.

2. The Debate over Compulsory Licensing

One of the most significant areas of controversy surrounding India's patent law is compulsory licensing.[120] Article 30 of TRIPS permits a member state to create exceptions to the exclusive rights of a patent holder.[121] Under Article 31, a state may issue a compulsory license under one or more patents without the authorization of the patent holder "in the case of national emergency or other circumstances of extreme urgency or in cases of public non-commercial use."[122] To this end, the 2001 Doha Ministerial Declaration on TRIPS and Public Health (Doha Declaration)[123] clarified that the manufacture of pharmaceuticals for use in a country need not occur in that country, which, in combination with compulsory licensing, paved

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117. *See* OFFICE OF THE CONTROLLER GENERAL OF PATENTS, DESIGNS AND TRADE MARKS, GUIDELINES FOR EXAMINATION OF COMPUTER RELATED INVENTIONS (CRIs) 13 (Feb. 19, 2016) (excluding "mathematical methods or business methods or computer programme per se or algorithms" from patentability).

118. *Statistical Country Profiles – India*, WORLD INTELL. PROP. ORG. (WIPO), http://www.wipo.int/ipstats/en/statistics/country_profile/profile.jsp?code=IN [https://perma.cc/4DL8-HEDR] (archived Oct. 2, 2016) [hereinafter WIPO, India]. The United States, in comparison, had more than 2.5 million patents in force in 2014, ranking first among countries. *Statistical Country Profiles – United States of America*, WORLD INTELL. PROP. ORG. (WIPO), http://www.wipo.int/ipstats/en/statistics/country_profile/profile.jsp?code=US [https://perma.cc/86LW-NS24] (archived Oct. 2, 2016).

119. Agreement on Trade Related Aspects of Intellectual Property Rights, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299 [hereinafter TRIPS Agreement].

120. *See generally* Jodie Liu, *Compulsory Licensing and Anti-Evergreening: Interpreting the TRIPS Flexibilities in Sections 84 and 3(d) of the Indian Patents Act*, 56 HARV. INT'L L.J. 207, 209 (2015); Omar Serrano & Mira Burri, *Making Use of TRIPS Flexibilities: Implementation and Diffusion of Compulsory Licensing Regimes in Brazil and India* 9–10 (World Trade Inst., Working Paper No. 1, 2016).

121. TRIPS Agreement, *supra* note 119, at art. 30.

122. TRIPS Agreement, *supra* note 119, at art 31(b).

123. World Trade Organization, Ministerial Declaration of 20 November 2001, WTO Doc. WT/MIN(01)IDEC/2 (2001).

the way for countries such as India to develop generic drug industries serving various export markets.[124]

Section 84 of the Indian Patents Act authorizes an Indian manufacturer to apply to the Controller General for a compulsory license under any Indian patent three years after its issuance if (1) the reasonable requirements of the public for the patented invention have not been satisfied, (2) the patented invention is not available to the public at a reasonably affordable price, and (3) the patent is not being sufficiently "worked" in India.[125] Several other provisions for compulsory licensing also exist in the Patents Act.[126]

In 2012, the Controller General issued India's first compulsory license at the request of Indian generic drug manufacturer Natco with respect to Bayer's liver cancer drug Nexavar. The license permitted Natco to manufacture the drug upon payment of a 6 percent royalty to Bayer.[127] The compulsory license was upheld by the Indian Intellectual Property Appellate Board, but with an increase of the royalty to 7 percent.[128] The issuance of this compulsory license gave rise to significant opposition from the Western pharmaceutical industry.[129]

Despite this precedent, the Controller General has declined to issue compulsory licenses on at least two occasions since 2012. First, it rejected an application by BDR Pharmaceuticals to obtain a compulsory license to manufacture Bristol-Meyers Squibb's (BMS) patented anti-cancer drug Dasatinib in 2013.[130] And in 2015 an application for a compulsory license by Lee Pharma, an Indian generic drug manufacturer, was rejected with respect to BMS's diabetes drug Saxagliptin.[131] Nevertheless, the Indian government has recently

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124. *See* RAGAVAN, *supra* note 110, at 73, 90–94.

125. Patents Act § 84(1). *See generally* Liu, *supra* note 120, at 215–17 (discussing requirements of § 84(1) in detail).

126. Patents Act at §§ 80, 92, 92A. *See* RAGAVAN, *supra* note 110, at 121–22.

127. Natco Pharma. Ltd. v. Bayer Corp., Compulsory License Application No. 1/2011 (Controller General of Patents, Designs and Trademarks, Mumbai, Mar. 9, 2012).

128. Bayer Corp. v. Natco Pharma. Ltd., Order No. 45/2013, para. 57 (Intellectual Property Appellate Board, Chennai, 2013).

129. *See, e.g.*, Ranjitha Balasubramanyan, *Battles over Patents: Is India Changing the Rules of the Game?*, INTELL. PROP. WATCH (Feb. 18, 2014), http://www.ip-watch.org/2014/02/18/battles-over-patents-is-india-changing-the-rules-of-the-game/ [https://perma.cc/9KR8-5FA6] (archived Oct. 2, 2016) (discussing Western opposition to compulsory licenses).

130. *See* KAMESHWARI SRIDHAR, INDIAN PATENT OFFICE'S RECENT DECISION ON SAXAGLIPTIN COMPULSORY LICENSE – A STEP TOWARDS MORE COHERENT INTERPRETATION OF INDIAN PATENT LAW'S CL PROVISIONS? 4–5 (2016) (application rejected largely on procedural grounds).

131. IPO Order No. C.L.A. No.1 of 2015, *In the matter of Lee Pharma Ltd vs AstraZeneca AB*, dated January 19, 2016 (rejecting application due to lack of evidence presented under all three prongs of Section 84 analysis). *See* SRIDHAR, *supra* note 130, at 7–9.

reiterated its position that compulsory licenses remain available in suitable cases.[132]

In addition to pharmaceuticals, the Indian government has indicated a willingness to consider compulsory licensing in the area of "green" technology. Thus, in the 2011 National Manufacturing Policy issued by the DIPP, the Indian government suggests that compulsory licenses may be available when patent holders are unwilling to license, or to charge reasonable rates for, patented green technology such as solar power, energy efficient vehicles, and emissions reduction technologies.[133]

The United States Trade Representative (USTR) has expressed concern regarding India's position with respect to the compulsory licensing of patents.[134] As a result, the USTR has, for the past several years, placed India on its Priority Watch List of countries whose internal laws and policies do not meet acceptable standards for intellectual property protection.[135] In an attempt to assuage these concerns, India has recently adopted measures intended to improve its status in the eyes of foreign governments, including its 2016 National Intellectual Property Rights Policy, which makes numerous assurances regarding India's respect for, and intention to enforce intellectual property rights vigorously.[136] It is not yet clear whether these measures have alleviated the concerns of the USTR or of other private interests in the West.

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132. *See* Alex Lawson, *India Won't Cease Controversial Drug Licensing Policy*, LAW360 (Mar. 24, 2016) http://www.law360.com/articles/775494/india-won-t-cease-controversial-drug-licensing-policy [https://perma.cc/RZ43-HM2V] (archived Oct. 10, 2016) (quoting statement by unidentified representative of Indian Ministry of Commerce and Industry: "Even as the government of India is conscious of the need to spur innovation and protect individual rights, it retains the sovereign right to utilize the flexibilities provided in the international IPR regime").

133. DEPARTMENT OF INDUSTRIAL POLICY & PROMOTION, MINISTRY OF COMMERCE AND INDUSTRY, NATIONAL MANUFACTURING POLICY § 4.4 (2011), http://dipp.nic.in/english/policies/national_manufacturing_policy_25october2011.pdf [https://perma.cc/95YS-QZJU] (archived Oct. 2, 2016). For a general discussion of compulsory licensing under TRIPS with respect to both pharmaceutical and green technologies, see Jorge L. Contreras & Charles R. McManis, *Compulsory Licensing of Intellectual Property: A Viable Policy Lever for Promoting Access to Critical Technologies?*, *in* TRIPS AND DEVELOPING COUNTRIES – TOWARDS A NEW IP WORLD ORDER? (Gustavo Ghidini, Rudolph J.R. Peritz & Marco Ricolfi eds., 2014).

134. AMBASSADOR MICHAEL B.G. FROMAN, OFFICE OF THE U.S. TRADE REP., 2015 SPECIAL 301 REPORT 49–50 (2015), https://ustr.gov/sites/default/files/2015-Special-301-Report-FINAL.pdf [https://perma.cc/43XL-XVCA] (archived Oct. 2, 2016) (criticizing the difficulty that firms have obtaining injunctions to prevent ongoing patent infringement and numerous inefficiencies at the IPO).

135. *Id.* at 45–46.

136. MINISTRY OF COMMERCE & INDUS., NATIONAL INTELLECTUAL PROPERTY RIGHTS POLICY (May 12, 2016).

B. *The Smart Phone Wars Reach India*

Unlike India's generic drug industry, which has thrived since the 1970s,[137] India's domestic mobile technology market is relatively young. As noted above, India did not play a significant role in the so-called smartphone wars that have been waged by industry giants such as Apple, Samsung, Microsoft, and Motorola in courts throughout North America, Europe, and the Asia Pacific region. There are several possible reasons that India and Indian firms may have been spared from the brunt of this litigation, including the relatively small market shares enjoyed to date by most Western technology firms in the domestic Indian market. Nevertheless, over the past few years, patent infringement suits against domestic Indian handset manufacturers, as well as Chinese firms serving the domestic Indian market, have begun to emerge.

1. Ericsson's Indian Patent Assertion Suits

The most active foreign enforcer of patents in the Indian telecommunications market is Stockholm-based Telefonaktiebolaget LM Ericsson (Ericsson), a multinational producer of telecommunications equipment and technology. Ericsson holds hundreds of Indian patents covering both standardized and non-standardized features of mobile telecommunications devices and infrastructure. It brought its first Indian infringement suit in 2011 against Kingtech Electronics, a Chinese manufacturer importing phones into India. Ericsson alleged that Kingtech infringed five of its patents covering adaptive multi-rate (AMR) codec technology.[138] In 2013, the Delhi High Court ruled in Ericsson's favor, ordering Kingtech to refrain from importing devices infringing the AMR patents.[139]

Beginning in 2013, Ericsson began to assert a larger group of eight patents including its five AMR patents, two patents covering 3G technology standardized by the European Telecommunications Standards Institute (ETSI), and one patent covering 2G (EDGE) technology, also standardized at ETSI. To date, Ericsson has asserted these patents in litigation against four Indian firms (Micromax Informatics Ltd., Best IT World India Pvt Ltd. (a/k/a iBall), Intex Technologies, and Lava Intl. Ltd.) and two Chinese firms importing mobile devices into the Indian market (Gionee and Xioami).[140] Though

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137. *See* Liu, *supra* note 120, at 208.

138. Televonaktiebolaget LM Ericsson v. Kingtech Elecs., CS(OS) 68/2012 (Del.) Order, Aug. 22, 2013, http://delhihighcourt.nic.in/dhcqrydisp_o.asp?pn=163228&yr=2013 [https://perma.cc/QJK4-3JSU] (archived Oct. 2, 2016).

139. *Id.*

140. For an in-depth discussion of these actions, see for example, J. Gregory Sidak, *FRAND in India: The Delhi High Court's Emerging Jurisprudence on Royalties for Standards-Essential Patents*, 10 J. INTELL. PROP. L. & PRACTICE 609, 610 (2015); Kirti

many of these cases are ongoing, to date Ericsson's patent claims against these firms have largely been successful, resulting in the award of both royalty damages and the imposition of injunctions against the sale and importation of infringing products into India.[141]

2. Vringo's Indian Patent Assertion Suits

Vringo, Inc., an international patent assertion entity, is engaged in the business of "innovation, development and monetization" of intellectual property, including through the assertion of "over 600 patents and patent applications covering telecom infrastructure, search, ad-insertion and mobile technologies."[142] In 2013 and 2014, Vringo Infrastructure, an Indian subsidiary of Vringo, Inc., asserted patents covering 2G and 3G wireless telephony against Indian subsidiaries of Chinese equipment giant ZTE[143] and Taiwanese PC manufacturer Asus Computer.[144] Unlike Ericsson's targeted enforcement actions against domestic Indian producers, Vringo's Indian suits are local skirmishes in its global patent disputes with other multinationals.[145] Vringo prevailed in its Indian action against ZTE,[146] and its suit against Asus is still pending in the Delhi High Court.[147]

Gupta, *FRAND in India: Emerging Developments, Antitrust in Emerging and Developing Countries,* CONFERENCE PAPERS (2016), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2771465 [https://perma.cc/8FQY-G7SG] (archived Oct. 2, 2016); Rohini Lakshané, *Compilation of Mobile Phone Patent Litigation Cases in India,* CENTRE FOR INTERNET & SOC'Y, http://cis-india.org/a2k/blogs/compilation-of-mobile-phone-patent-litigation-cases-in-india (last visited Oct. 25, 2016) [https://perma.cc/WYU5-4FM5] (archived Oct. 2, 2016).

141. *See* Lakshané, *supra* note 140; Sidak, *supra* note 140.

142. Vringo, Inc., Annual Report (Form 10-K) at 5 (Mar. 10, 2016), https://www.sec.gov/Archives/edgar/data/1410428/000114420416087235/v432779_10k.htm [https://perma.cc/EZH8-LNFE] (archived Sept. 30, 2016). One of the authors (Contreras) filed an Affidavit on behalf of Vringo in its Brazilian litigation against ZTE.

143. Vringo Infrastructure Inc. v. Indiamart Intermesh Ltd., No. 2112/2014, Order (Delhi HC Aug. 5, 2014).

144. Vringo Infrastructure Inc. v. Nuage Techsol Pvt. Ltd., Complaint (Delhi HC Apr. 14, 2014).

145. *See, e.g.*, Jack Ellis, *Vringo and ZTE Go the Distance: An Infographic,* INTELL. ASSET MGMT. BLOG (Dec. 15, 2015), http://www.iam-media.com/blog/Detail.aspx?g=fe946e60-87b7-4840-81fd-0513a847aa51 (subscription required) (last visited Sept. 30, 2016) [https://perma.cc/2MUJ-YY63] (archived Sept. 30, 2016) (describing litigation between Vringo and ZTE in twelve different jurisdictions).

146. Vringo Infrastructure Inc. v. Indiamart Intermesh Ltd., No. 2112/2014 (Delhi HC Aug. 5, 2014). Following this judgment, Vringo and ZTE settled their worldwide patent dispute. *See* Jack Ellis, *Vringo's $21.5 million global settlement with ZTE reflects the IP market's new realities,* INTELL. ASSET MGMT. BLOG (Dec. 8, 2015), http://www.iam-media.com/blog/detail.aspx?g=16c03b05-cd13-46c3-9e55-eb0a57c99a57 [https://perma.cc/Z23T-DTC2] (archived Sept. 30, 2016).

147. *See* Lakshané, *supra* note 140.

3. Competition Commission Investigations

In response to Ericsson's patent infringement suits, several defendants have challenged Ericsson's conduct under Indian competition law.[148] The first such action was initiated by Micromax in 2013 by filing a complaint with the Competition Commission of India (CCI).[149] The complaint alleged that Ericsson violated the Indian Competition Act[150] through abuse of its patent-conferred dominant position.[151] Specifically, Micromax argued that the royalties sought by Ericsson for the asserted patents were exorbitant in view of Ericsson's commitments to license those patents on terms that were fair, reasonable, and nondiscriminatory.[152] The CCI issued a preliminary order finding evidence that Ericsson had abused the dominant position created by its standard-essential patents and ordered a full investigation by the Director General.[153] Similar competition claims against Ericsson were brought by Intex[154] and iBall.[155]

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148. For an overview of the theories asserted in such actions, see generally Shubha Ghosh & D. Daniel Sokol, *FRAND in India* 4–7, 10–13 (Univ. of Wis. Legal Studies Research Paper No. 1374, Apr. 23, 2016), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2718256 [https://perma.cc/UG4W-JU3A] (archived Sept. 30, 2016); Yogesh Pai & Nitesh Daraynani, *Patents and Competition Law in India: CCI's Reductionist Approach in Evaluating Competitive Harm* (Oct. 26, 2016), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2859546 [http://perma.cc/TP6G-B5FV] (archived Nov. 30, 2016); Sidak, *supra* note 140.

149. Competition Comm'n India, Order - Micromax Informatics Ltd., CCI Case No. 50/2013, ¶ 8, at 4 (Nov. 11, 2013) [hereinafter Micromax, CCI Case No. 50].

150. Competition Act of 2002, No. 12, Ch. 2, § 4, Acts of Parliament, 2003.

151. Micromax, CCI Case No. 50, *supra* note 149.

152. *Id.* Such "FRAND" commitments are commonly made by participants in standard-setting organizations. *See* DEP'T OF INDUS. POLICY AND PROMOTION (DIPP), MINISTRY OF COMMERCE & INDUS., DISCUSSION PAPER ON STANDARD ESSENTIAL PATENTS AND THEIR AVAILABILITY ON FRAND TERMS 10 (Mar. 1, 2016) [hereinafter DIPP Discussion Paper].

153. Micromax, CCI Case No. 50, *supra* note 149, ¶ 19, at 8. The investigation was suspended for more than two years after Ericsson petitioned the Delhi High Court to intervene. Telefonaktiebolaget LM Ericsson v. Competition Comm'n of India, W.P No. (C) 464/2014, Court Vide Order, (Delhi HC Jan. 21, 2014). However, the High Court has recently permitted the investigation to resume. Telefonaktiebolaget LM Ericsson v. Competition Comm'n of India, W.P No. (C) 464/2014, Judgment (Delhi HC Mar. 30, 2016). The Delhi High Court found that Ericsson as an "enterprise" and patents and licenses as "goods and services" fall under the purview of India's Competition Act. *Id.* at ¶¶ 91–93. However, it also noted that the scope of inquiry under the Competition Act would be restricted to determining whether there has been abuse of dominant position. *Id.* at ¶¶ 105–07.

154. Competition Comm'n India, Order - Intex Technologies Ltd., CCI Case No. 76/2013 (Jan. 16, 2014). *See generally* DIPP Discussion Paper, *supra* note 152, at 23–25.

155. Competition Comm'n India, Order - Best IT World (India) Pvt. Ltd., CCI Case No. 4/2015 (May 12, 2015), http://www.cci.gov.in/sites/default/files/042015_0.pdf [https://perma.cc/PQ6M-JRLK] (archived Oct. 1, 2016). *See generally* DIPP Discussion Paper, *supra* note 152, at 24. It has been reported that iBall and Ericsson have reached an out-of-court settlement and entered into a global license agreement. Rajesh Kurup, *iBall, Ericsson Settle Patent Issue*, HINDU BUS. LINE (Nov. 20, 2015),

IV. THE MOBILE DEVICE PATENT LANDSCAPE IN INDIA

Given the importance of mobile technology to India's national economy, development, and infrastructure, and the recent patent litigation surrounding mobile device technology in India, we sought to gain a better understanding of the patent landscape of the mobile device market in India. This Part describes the results of a comprehensive study of Indian patent applications and issued patents in a selected set of industry classes pertaining to mobile devices. We sought, in particular, to determine the ownership of Indian patents in this sector and the degree to which such patents are held by firms based outside of India.

A. *Prior Studies*

1. General (Global) Studies

Several general studies of the patent landscape in the mobile telecommunications sector have previously been conducted. For example, in 2012 the Center on Law and Information Policy (CLIP) at Fordham University School of Law conducted an in-depth study of the impact of patents on the smartphone industry on behalf of the World Intellectual Property Organization (WIPO).[156] The CLIP study identified thirty-seven key market participants and their relevant market shares, patent holdings, publicly available licenses, and information regarding litigation. The data were compiled from a combination of public sources and targeted surveys.

A more focused study of the global patent landscape, relating to 4G-LTE technology, was conducted by market research firm iRunway in 2012.[157] Like the CLIP study, iRunway identifies key global patent holders and patent categories relevant to LTE technology, as well as patent filing and litigation trends. In 2013, the Centre for Internet and Society in India commissioned a survey of mobile telephony patents issued primarily by the U.S. Patent and Trademark Office for use, among other things, as prior art in Indian patent examinations.[158] Approximately 2,440 such patents were identified in various technical categories.

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http://www.thehindubusinessline.com/info-tech/iball-ericsson-settle-patent-issue/article7900713.ece [https://perma.cc/KEM4-GQ3Z] (archived Oct. 2, 2016).

156. CLIP 2012 Study, *supra* note 14.

157. IRUNWAY, PATENT & LANDSCAPE ANALYSIS OF 4G-LTE TECHNOLOGY (2012), http://www.i-runway.com/images/pdf/iRunway%20-%20Patent%20&%20Landscape%20Analysis%20of%204G-LTE.pdf [https://perma.cc/59FU-E94R] (archived Oct. 2, 2016).

158. Nehaa Chaudhari, *Mobile Phone Patents: Prior Art Survey*, CTR. FOR INTERNET & SOC'Y: ACCESS TO KNOWLEDGE BLOG (Oct. 23, 2013), http://cis-india.org/a2k/blogs/mobile-phone-patents [https://perma.cc/B43G-V4HP] (archived Oct. 2, 2016).

In 2014, Ann Armstrong of Intel Corporation and two private practitioners released a working paper investigating the patent coverage of a typical smartphone and the "royalty stack" associated with such patents.[159] Using a subsystem-based analysis, they estimated that a hypothetical $400 smartphone would be subject to patent royalties (disregarding any cross-licensing reductions) in excess of $120. Also in 2014, the European Commission published an extensive report analyzing the impact of patents on technical standards, a significant portion of which was devoted to the mobile telecommunications sector.[160]

2. India-Focused Studies

The above studies address the overall patent coverage of mobile devices on a global basis, with a focus on North America and Europe. India generally does not figure in these analyses. We are aware of only one publicly available study of patenting in the Indian telecommunications sector—a 2010 study conducted by Clairvolex, a local market research firm.[161] The Clairvolex study relied on a proprietary database of Indian patent records and covered Indian patent applications published from 2005 through 2010. The study identified the top filers of Indian patent applications in telecommunications-related technology classifications and charted the trends in filing behavior over the period studied.

Clairvolex identified approximately 7,400 Indian patent applications in the relevant technology categories. Of the eight "key players" in the market identified by Clairvolex, all were non-Indian firms, as summarized in Table 1.[162]

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159. Ann Armstrong et al., *The Smartphone Royalty Stack: Surveying Royalty Demands for the Components Within Modern Smartphones* (May 29, 2014), http://papers.ssrn.com/so13/papers.cfm?abstract_id=2443848 [https://perma.cc/PDY3-K5YK] (archived Oct. 2, 2016).

160. EUROPEAN COMMISSION DIRECTORATE-GENERAL FOR ENTERPRISE AND INDUSTRY, PATENTS AND STANDARDS: A MODERN FRAMEWORK FOR IPR-BASED STANDARDIZATION 57–68 (2014), http://ec.europa.eu/DocsRoom/documents/4843/attachments/1/translations/en/renditions/pdf [https://perma.cc/XDP5-LP7F] (archived Oct. 2, 2016).

161. CLAIRVOLEX, INC., *supra* note 16.

162. Clarivolex does not explain how it selected the eight key players studied. Assuming that these are simply the eight firms holding the greatest number of Indian patents in the telecommunications sector, no information is provided regarding firms holding fewer than 363 patents.

Table 1
"Key Players" Holding Indian Telecommunications Patents
(Clairvolex 2010)

Clairvolex "Key Player"	Nationality	Number of Indian Telecom Patent Applications Held
Qualcomm	United States	1,951
Ericsson	Sweden	1,232
Samsung	Korea	1,103
Nokia	Finland	1,154
Motorola	United States	626
RIM/Blackberry	Canada	558
LG	Korea	626
Sony-Ericsson	Japan	363

These findings are consistent with statistics reported by WIPO regarding the distribution of Indian patents among resident and non-resident firms. Thus, in 2014, of a total of 6,153 patents issued in India in all fields, only 720 (12 percent) were issued to domestic Indian firms, while 5,433 were issued to non-Indian firms.[163] Likewise, of the 42,854 patent applications filed in India in 2014, 12,040 (28 percent) were filed by domestic Indian firms, while 30,814 (72 percent) were filed by non-Indian firms.[164] These statistics, while supporting the earlier study's finding that all major holders of Indian patents in the telecommunications field are non-Indian companies, may actually *overstate* the representation of Indian patent holders in the telecommunications field, as the majority of Indian patent applications filed from 2000 to 2014 related to pharmaceuticals (19.91 percent) and organic chemistry (18.10 percent). Computer technology applications represented only 14.31 percent of the total, while "digital communication" patent applications constituted a mere 3.59 percent of the total number of applications filed. Thus, it is possible that aggregate statistics relating to domestic holding of Indian patents may, in fact, reflect the status of fields such as pharmaceuticals and chemicals, and that Indian firms may hold far fewer patents in the field of mobile telecommunications.

There are three reasons that a new study of the Indian telecommunications patents was needed. First, the Clairvolex study was conducted in 2010, prior to the emergence of a significant domestic Indian mobile device industry. Second, the Clairvolex study provides no information regarding the "low end" of the patent holding spectrum (i.e., below the top eight foreign "key players"). And third, the study

163. WIPO, India, *supra* note 118 (patent grants).
164. WIPO, India, *supra* note 118 (patent applications).

was conducted by a commercial firm based on proprietary data and search methodologies which were not disclosed to the public. This Article updates the Clairvolex findings with the new, more comprehensive, and publicly accessible data.

B. *Methodology*

In order to assess the Indian patent landscape relating to mobile devices, we developed a search strategy to utilize the Indian Patent Office (IPO) records of issued patents and published patent applications.[165] These records can be accessed and searched either through the IPO or through the Derwent World Patent Index (DWPI), which is made available through Thomson Innovation (TI).[166] DWPI was the database selected, as it offers additional data (such as assignee records), front end tools, and searching and access that is superior to the electronic records of the IPO itself. The DWPI database also contains editorially enhanced titles and abstracts of issued Indian patents from 2000, and published Indian patent applications from 2005.

To execute the relevant searches and compile the results, a commercial patent searching firm in India familiar with the DWPI system was engaged. Informal interviews with leading Indian patent law firms were conducted in order to compile a list of reputable patent search firms from different parts of India. Written bids were then solicited from ten of these search firms. Bids included a description of the firm's experience and qualifications, a proposed work plan and timetable, and a price quotation. Based on these responses, two independent firms were selected to perform searches for this study. During the course of the study, the performance of one of the selected firms became unacceptable, leaving a single firm (Hourglass Research, Mumbai, India) to perform the bulk of the searching tasks.

The search firm constructed search queries based on a list of fifty leading Indian and non-Indian mobile telecommunications firms in the industry (see Appendix A). The list of target firms was compiled based on the firms identified in the global telecommunications patent study conducted by CLIP in 2012,[167] as well as listings of top mobile device

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165. Indian patent applications are published eighteen months after filing. *See* KANKANALA ET AL., *supra* note 109, at 66–67.

166. THOMSON REUTERS, THOMSEN INNOVATION® PATENT COVERAGE, http://www.info.thomsoninnovation.com/sites/default/files/assets/L-367541.pdf (last visited Oct. 25, 2016) [https://perma.cc/T4XS-5GLD] (archived Oct. 2, 2016). Access to the DWPI through Thomson Innovation is available to the public for a fee.

167. Kirti Gupta and Mark Snyder catalog the top twenty-two U.S. smartphone litigants in 2014. Kirti Gupta & Mark Snyder, *Smart Phone Litigation and Standard Essential Patents* (Hoover Institution Working Paper No.14006, 2014). Our search query included each of these entities.

vendors in the Indian market.[168] A taxonomy of mobile device systems and subsystems was then developed (see Appendix B).

The DWPI database was queried in February 2015 using a series of text-based search strings that combined keywords relating to mobile device technology, International Patent Classification (IPC) codes, and the names of targeted firms. The published patent applications and issued patents that were identified were de-duplicated based on International Patent Documentation (INPADOC) patent family identifiers, whereby patents and applications bearing the same INPADOC number in the DWPI database were treated as a single document (with the issued patent taking priority over any corresponding applications). All resulting patent documents were classified according to the taxonomy in Appendix B. All cleaned and validated data have been made available on the Centre for Internet and Society website.[169]

C. *Findings*

A total of 19,569 published Indian patent applications and 4,052 issued Indian patents relating to mobile devices were identified from January 2000 through February 2015.[170] Table 2 below illustrates the breakdown of these patents into ten high-level technology categories, organized by year of filing.[171]

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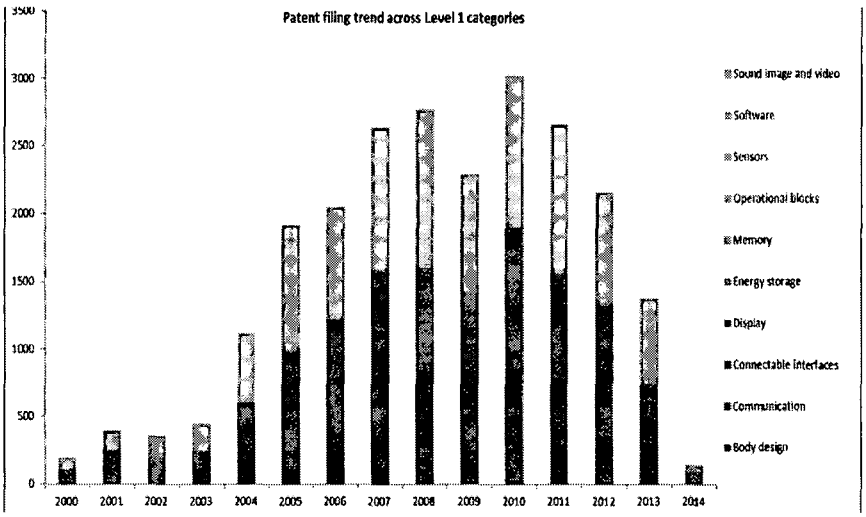
168. *See* IDC 2015 Report, *supra* note 4; COUNTERPOINT 2015, *supra* note 4.

169. Rohini Lakshané, *Dataset: Patent Landscape of Mobile Device Technologies in India*, CTR. FOR INTERNET & SOC'Y: ACCESS TO KNOWLEDGE BLOG (Apr. 2, 2016), http://cis-india.org/a2k/blogs/dataset-patent-landscape-of-mobile-device-technologies-in-india [https://perma.cc/HEL3-LEQ2] (archived Oct. 2, 2016).

170. For convenience of reference, in this study we refer to all issued patents and published patent applications as "patents."

171. A significant lag exists in the recognition of patents for 2013 and 2014, given the eighteen-month delay in publishing these applications.

Table 2
Patent Applications by Year and Technology Category



The technology category with the single greatest number of patents (including both applications and issued patents) was communications (12,857), which was broken into nine distinct sub-categories (see Appendix B). There were 3,407 patents covering operational blocks and 3,068 patents covering software-related features such as the operating system, message display, searching, file management, and ringtone management.[172]

Table 3 sets out the top eleven holders of patents based on this search.[173] Consistent with the results of prior studies, all of these entities are non-Indian and are based in North America, Europe, or the Asia-Pacific region.

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172. The presence of this many software-related patents was surprising, given India's general policy prohibiting the issuance of software patents. *See* Patents Act 1970 (Amendments 2002), No. 38, Sec. 3 (prohibiting patenting of various computer-related inventions); OFFICE OF THE CONTROLLER GEN. OF PATENTS, DESIGNS & TRADEMARKS, GUIDELINES FOR EXAMINATION OF COMPUTER RELATED INVENTIONS (CRIS) (Feb. 19, 2016), http://tematelecom.in/pdf/GuidelinesExamination_CRI_19February2016.pdf [https://perma.cc/E2UQ-AV8C] (archived Oct. 2, 2016).

173. These results reflect the most recent assignee of each patent as of the end of the search period. While online IPO records do not currently make subsequent assignee details available, this data is available through the Thompson Innovation database. Some patents in our survey were assigned as many as four times.

Table 3
Indian Patents and Applications in Telecommunications: Top Assignees (2000–2015)

Assignee	Nationality	Total Published Indian Applications and Issued Patents
Qualcomm	United States	5,954
Ericsson	Sweden	1,843
Samsung	South Korea	1,827
Nokia[174]	Finland	1,744
Microsoft	United States	1,557
Philips	Netherlands	1,460
Sony	Japan	1,235
Alcatel-Lucent	France	971
Motorola	United States	842
LG	South Korea	791
RIM/Blackberry	Canada	782

While Table 3 presents data relating to the top eleven holders of Indian patents, the study compiled patent ownership data for all fifty entities listed in Appendix A. Of these, thirty-eight were non-Indian and twelve were Indian. Of approximately 23,500 total patents identified, a total of only *eighteen* patent applications, but no issued patents, were held by three of the Indian firms studied (Spice Digital, HCL, and Videocon). The other nine Indian firms in the survey held no patents or applications.[175]

In a follow-up search, the IPO online database was queried on April 1, 2016 for patents and patent applications held by the twelve Indian firms in the original search, plus nineteen additional Indian mobile device producers.[176] No additional patent applications or issued patents were identified. However, for the period following the original search window, fifty-five new published patent applications (by Indian firm HCL) were identified.

A search was also run for patents held by Indian "value added service" vendors in the telecommunications sector (Level 1 of the Software category shown in Appendix B). The results identified ten patent applications held by Comviva, twenty-one patent applications

174. Many Nokia patents are now held by Vringo. *See Vringo Announces Fourth Quarter and Year End Results for 2012*, EURO INVESTOR (Mar. 21, 2013), http://www.euroinvestor.com/news/2013/03/21/vringo-announces-fourth-quarter-and-year-end-results-for-2012/12259574 [https://perma.cc/7VU8-KKFP] (archived Oct. 2, 2016) (announcing acquisition of portfolio of more than 500 patents from Nokia).

175. *See* Appendix A.

176. *See* Appendix C.

held by MobMe, and twenty applications and one issued patent held by OnMobile.

D. *Analysis: Explaining the Disparity*

The disparity in patent holdings as between Indian and non-Indian firms are striking. Despite the fact that more than 150 firms compete in the Indian mobile device marketplace, collectively, domestic firms hold almost no patents. And Western firms that have little or no presence in the Indian device market hold substantial portfolios with thousands of patents each. How can this disparity be explained?

It is not difficult to understand the accumulation of Indian patents by non-Indian multinational technology firms. These firms are not only active patent-seekers in India, but throughout the world. Not surprisingly, nearly all of the top eleven Indian patent holders in this study appear toward the top of CLIP's list of thirty-seven top global telecommunication patent holders.[177] Thus, as part of their global patent acquisition strategies, these firms routinely acquire patents in India, which is a large and rapidly growing mobile technology market. Moreover, it can be assumed that most Western technology firms take advantage of filings under the Patent Cooperation Treaty (PCT), which permits relatively straightforward local applications to be made in PCT member countries, such as India (particularly given that India's official language for filing is English).[178]

More puzzling, however, is the striking lack of patents held by Indian firms. Why do Indian firms hold so few Indian patents in a market full of domestic competitors? One theory is that Indian firms are not innovative and simply wish to copy technologies developed elsewhere. But this characterization is naive, unfair, and demonstrably untrue. In the pharmaceutical sector, for example, Indian firms file a substantial number of patent applications both in India and abroad for new drug discoveries.[179] And, based on the informal survey of the breadth and variety of mobile devices offered by Indian firms, it appears that Indian mobile device producers display substantial levels of innovation, ingenuity, and inventiveness in their product design and execution.[180] Thus, a lack of innovation is likely not the cause for the absence of patenting by Indian firms.

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177. CLIP 2012 Study, *supra* note 14, at App. IV. One exception is Philips, which, while listed in CLIP's list of top thirty-seven patent holders inexplicably does not appear in Appendix IV of the CLIP study report, which only lists thirty-five firms.

178. *See* KANKANALA ET AL., *supra* note 109, at ch. 11.

179. *See, e.g.*, US–INDIA BUS. COUNCIL, THE VALUE OF INCREMENTAL PHARMACEUTICAL INNOVATION: BENEFITS FOR INDIAN PATIENTS AND INDIAN BUSINESS 2 (2009), http://www.indiaenvironmentportal.org.in/files/USIBCIncrementalInnovation ReportFinal.pdf [https://perma.cc/SM6T-KL4B] (archived Oct. 2, 2016).

180. *See* Contreras, *supra* note 11.

Another possible explanation is cultural: Indian electronics and telecommunications firms, as well as Indian research institutions and universities, may simply lack a tradition of domestic patent filing in the telecommunications sector. The absence of a patenting culture could be attributable to a variety of factors, including the general lack of faith in the Indian patent system coupled with the realization that short product cycles combined with lengthy patent prosecution delays[181] may result in patents that, once issued, have little commercial value (i.e., they may cover only the previous generations of products).

Finally, cost may play a role in the unwillingness of Indian firms to pursue patent protection in the telecommunication sector. As noted above, Indian vendors dominate the low end of the mobile device market. They procure low-cost hardware from China and Taiwan, load it with open source and locally-developed apps, then sell it on the domestic Indian market at prices ranging from $100 down to the extreme low of Ringing Bells' $4 price point. At these rock bottom prices, profit margins are likely to be thin to non-existent, perhaps making the additional cost of filing patent applications uneconomical.

E. *Areas for Further Study*

This study is based on quantitative patent filing data from IPO records. While these data offer a picture of extreme disparities in the Indian patent holdings of Indian and non-Indian firms, they do little to explain the reasons underlying this disparity. Further research is needed to assess the causes of this disparity and the general failure of Indian firms to pursue patents in the mobile device market. Such research could include surveys and structured interviews with individuals involved in the Indian mobile device market.

Another potential area of future research involves standard-essential patents that may be asserted in the Indian mobile device market, and the degree to which such patents are encumbered by commitments to license such patents on terms that are fair, reasonable, and non-discriminatory (FRAND). Several of the patent suits involving Ericsson and Indian and Chinese producers have raised FRAND issues. However, as other commentators have pointed out,[182] the analysis conducted in these cases by the Competition Commissions of India and the Delhi High Court has been cursory and lacking in sophisticated economic modeling. In order to assist Indian courts and agencies in future proceedings, further research regarding the financial structure of, and expectations and norms within, the Indian mobile device market is warranted.

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181. *See supra* text accompanying notes 114–15 (discussing patent prosecution delays of eight to nine years).

182. *See, e.g.*, Ghosh & Sokol, *supra* note 148, at 5.

V. CONCLUSION

India is the world's second largest mobile communications market. Though it has remained largely unaffected by the smartphone wars that have been fought in the developed world for the past decade, Indian manufacturers can no longer ignore patents. Foreign firms already dominate the mobile device patent landscape in India, and, if more follow Ericsson's example and begin to assert their patents against domestic producers, these producers may be severely disadvantaged, if not driven out of business. The aggressive assertion of patents by multinational firms against India's low-cost domestic producers could reduce the supply of inexpensive mobile devices available to the Indian population, thereby limiting the many social, health, and economic benefits afforded by mobile technologies.[183] In this respect, the debate over patents and mobile technology may come to resemble the decades-long battles over access to affordable medicines that India and other developing countries have experienced.

In the face of these threats to the domestic mobile technology market, several proposals have been made by us and others. Rohini Lakshané, for example, together with the Centre for Internet and Society, has requested that the Indian government establish a patent pool covering critical mobile technologies and that licenses to such pool be made available to all domestic manufacturers at a fixed royalty rate of 5 percent of the end product's net selling price.[184] Jorge Contreras, in connection with the National Science Foundation and the East-West Center's 2016 Workshop on Mega-Regionalism, has suggested that governments in developing countries actively promote and subsidize engagement by domestic firms in international standard-setting and technology development organizations in order to enhance their integration into the global technology development infrastructure and in order to improve their bargaining posture with technology incumbents.[185] Other scholars have proposed additional mechanisms for equalizing the disparities in patent holdings among firms in both developing and developed countries.[186]

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183. *See supra* Section I.B.

184. Rohini Lakshané, *Open Letter to Prime Minister Modi*, CTR. FOR INTERNET & SOC'Y: ACCESS TO KNOWLEDGE BLOG (Mar. 24, 2015), http://cis-india.org/a2k/blogs/open-letter-to-prime-minister-modi [https://perma.cc/YDY7-AWEZ] (archived Oct. 1, 2016).

185. Jorge L. Contreras, *Patents, Standards and Borders: Addressing National Disparities among Holders of Standard-Essential Patents* (East-West Ctr. Workshop on Mega-Regionalism, Honolulu, Haw., Conference Paper, Jan. 20–21, 2016), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2726237## [https://perma.cc/LF84-2PEQ] (archived Oct. 2, 2016).

186. *See, e.g.*, Florian Ramel, Maximlian von Laer & Knut Blind, *Standard Essential Patents and the Distribution of Gains from Trade for Innovation* (East-West Ctr. Workshop on Mega-Regionalism, Honolulu, Haw., Conference Paper, Jan. 20–21,

While a detailed assessment of these and other proposals are beyond the scope of this study, we hope that the data presented here will assist scholars and policy makers in assessing potential measures for addressing these significant disparities in the patent landscape of the Indian mobile device market.

2016), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2745496 [https://perma.cc/4UC7-3AT3] (archived Oct. 2, 2016).

APPENDIX A

Telecommunications Firms and Indian Patents and Patent Applications (2000–2015)

No.	Assignee	Nationality	Patents and Apps
1	Qualcomm	United States	5,954
2	Ericsson	Sweden	1,843
3	Samsung	South Korea	1,827
4	Nokia	Finland	1,744
5	Microsoft	United States	1,557
6	Philips	Netherlands	1,460
7	Sony	Japan	1,235
8	Alcatel Lucent	France	971
9	Motorola	United States	842
10	LG	South Korea	791
11	RIM/Blackberry	Canada	782
12	Panasonic	Japan	537
13	NTT Docomo	Japan	523
14	Huawei	Japan	470
15	Siemens	Germany	366
16	Intel	United States	331
17	ZTE	China	303
18	InterDigital	United States	288
19	Apple	United States	256
20	Hewlett-Packard	United States	225
21	NEC	Japan	209
22	IBM	United States	203
23	Cisco	United States	165
24	Google	United States	132
25	Fujistu	Japan	89
26	Canon	Japan	87
27	Hitachi	Japan	84
28	Yahoo	United States	70
29	Oracle	United States	59
30	Toshiba	Japan	36
31	AT&T	United States	23

No.	Assignee	Nationality	Patents and Apps
32	SAP	Germany	22
33	ETRI	South Korea	21
34	Broadcom	United States	17
35	Nortel	Canada	17
36	Texas Instruments	United States	12
37	HCL	India	11
38	Spice Digital	India	6
39	Videocon	India	1
40	HTC	Taiwan	0
41	Sprint	United States	0
42	Karbonn	India	0
43	Intex	India	0
44	Lava	India	0
45	Micromax	India	0
46	Xolo	India	0
47	Datawind	India/Canada	0
48	Salora International	India	0
49	Simmtronics	India	0
50	Onida	India	0
	Total		23,569

APPENDIX B

Taxonomy with Categorization and Sub-Categorization of Patents

Level 1	Level 2	Patents and Apps	Description
Communication		12,857	
	Power control and optimization of RF signals	503	Techniques for transmission power control in uplink and downlink to optimize/increase efficiency of RF signal transmission, including power allocation.
	Signaling, routing and switching	2,857	Packet routing techniques between user equipment (UE) and base stations, Mobile Management Entity (MME), gateway, and nodes such as routers and switches. Includes peer-to--peer networks.
			Synchronization of receiver with transmitter based on clock, phase, synchronous, frame delay, lock, recover, regenerate, and bit stuffing modes. Includes clock generation and correction, care of address, beacon transmission, and paging.
			Includes signaling methods such as request-acknowledgement loops between UE and base station. Includes layout or design of a cellular telephone system, the arrangement of cells and base stations, or novel methods of operating the network involving signaling and paging. Includes exchange and system aspects specific to mobile telephone networks.

Level 1	Level 2	Patents and Apps	Description
			Includes selection transmission modes.
	Call and data management	3,830	Registering a mobile subscriber, location registers, covers billing and usage aspects of data network services, tracing caller IDs, topology of the network, ringing, call screening, and call handling. Handover techniques used in roaming. Selection of networks and cells.
	Error prevention, detection, and correction	845	Includes techniques related to error prevention, detection, and correction. Monitors redundancy and bit error rate (BER), various coding schemes such as block codes and convolutional codes, interleaving, and turbo codes and puncturing.
	Bandwidth control and optimization	2,414	Methods to increase bandwidth efficiency.
			Methods to increase bandwidth and speed of data transmission. Includes frame aggregation, packet aggregation, and increased link rate, quality of service (QoS), and channel quality indicator (CQI) or channel state estimation (CSE).
			Resource allocation by base station and adjustment by UE during uplink communication.
			Echo cancellation, noise reduction, and diversity systems used to improve

Level 1	Level 2	Patents and Apps	Description
			quality and reliability of wireless link.
	Multiple access methods and network protocols	519	Includes description of network protocols, CDMA and other multiple access methods, network protocol conversion, encapsulation, and tunneling.
			Structure of data packets and headers.
	Passband modulation	454	Modulation techniques such as time-division multiplexing (TDM), frequency-division multiplexing (FDM), frequency-shift keying (FSK), phase-shift keying (PSK), spatial multiplexing, and OFDM.
	Security	822	Encryption techniques such as RSA and WiFi-Protected Access (WPA), and hashing algorithms used in wireless communication.
	Location reporting	613	Location reporting techniques in a wireless communication system that is required for GPS and location based services.
Operational blocks		3,407	
	Antenna structures and interfaces	234	Design of antenna interfaces such as multiple-input and multiple-output (MIMO) and placement of antenna for beamforming.
	Security	400	Password, access code, access keys, card reader, digital rights management (DRM), digital certificates, and signatures.
	RF transceivers	704	Systems for amplifying the signal prior to transmission

Level 1	Level 2	Patents and Apps	Description
			through antenna, equalizers, phase-locked loops (PLL) and DLL, and filters.
			Includes radio frequency (RF) mixers and splitters to divide data streams into sub-streams.
	Data converters	44	Includes baseband data conversion units such as ADCs and DACs.
	Application processing	641	Interpreting and executing commands from the user interface (UI). Connected to components such as PMIC, LCD display, Bluetooth, camera, and Wi-Fi modules for processing inputs received from these components to execute essential tasks.
	Baseband	1,115	Includes all radio electronic components and is connected to the RF transceiver. Responsible for processing received analog signals from the RF transceiver, and generating and transmitting pre-coding matrix.
	Power management	269	Techniques of power management in mobile phones and the integrated circuits (ICs) used therein.
Memory		415	
	Memory	415	Types and structure of memories that may include RAM, ROM, flash memories, and external media.
			Memory management unit and controller, translation buffers, and page tables for

Level 1	Level 2	Patents and Apps	Description
			virtual memory addressing and translation.
Sensors		531	
	Gyroscope	14	Sensor to enable identification of orientation of the device.
	Accelerometer	20	Sensor to enable identification of speed and inertia of the device.
	Touchscreen	211	Structure of the touch sensor and type of touchscreen (resistive and capacitive).
			System for identifying data received from touchscreen, conditioning of touch data, and controlling of the touch sensor.
	Camera	252	Primary and secondary camera sensor types and structures, such as CMOS and CCD sensors.
			System for processing and conditioning data received from a camera sensor. May include systems for image stabilization and exposure control.
			Sensor assembly to implement zoom levels, and movement and rotation of sensors.
	Proximity	17	Sensor controllers to control operation of the infrared (IR) sensors.
	Magnetometer	2	Instruments used for measuring magnetic forces, especially the earth's magnetism.
	Light sensor	15	Includes controlling display brightness based on how much ambient light is present.

Level 1	Level 2	Patents and Apps	Description
Sound, image, and video		2,132	
	Audio and video processing	1,512	Audio sensor such as microphone to sense audio of the user.
			Systems and sensor assembly to reduce ambient noise and interference.
			Signal processing techniques for post-processing of audio prior to provision to speaker.
			Audio and video coding such as MPEG, H.264, and video processing.
			Audio outputs such as speakers.
	Image processing	620	Processing of images at pixel level.
Body design		274	
	Body design	274	Optimum placement of components during assembly of the phone. Includes internal construction, i.e., PCB mounting, and constructional aspects of display.
Energy storage		175	
	Battery	127	Battery structure and type, such as LiPo and Li-ion.
	Wireless charging	48	Inductive charging mechanisms and assembly.
Display		599	
	Screen technology and display circuit	597	Different types of screen technologies, such as LED, LCD backlight, AMOLED, LCD, SLCD, SCLCD.
			Includes novel details of display circuitry and the typical additional uses of displays on telephone sets.

Level 1	Level 2	Patents and Apps	Description
	Display protection	2	Different types of display protection such as Gorilla Glass 3 or sapphire protective glass.
Software		3,068	
	Basic phone applications	3,068	Includes functions performed by the operating system (OS) of the phone, such as the displaying of text messages, searching, file management, and ringtone management.
Connectable interfaces		111	
	Interface	111	Design and structure of interface such as USB, audio jack, charging ports, microHDMI, SIM card slots, and memory card slots.
			Examples: USB controller, HDMI controller, and USB pre-driver circuit.

APPENDIX C

Additional Indian Mobile Device Firms Searched in the IPO Database (Apr. 1, 2016)

1. Maxx
2. Celkon
3. Olive Telecommunications
4. Fly Mobiles
5. Vox Mobiles
6. Zen Mobile
7. Lemon Mobiles
8. Quad Electronic Solutions Pvt Ltd.
9. Movil Mobiles
10. Digiflip
11. Swipe Telecom
12. Obi Mobiles
13. MTS
14. AirTyme Communications
15. YU Televentures
16. Zync
17. Ringing Bells
18. Lyf
19. Beetel