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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 three 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 a comprehensive patent landscape analysis of the mobile device sector in India using public data relating to Indian patent ownership by technology type, nationality, and industry classification. Our results illuminate a number of important features of the 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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INTRODUCTION

India has the second-largest mobile telephone subscriber base in the world, with nearly one billion wireless subscribers in 2015.[1] Until recently, the Indian market for mobile handsets (including both feature phones and smartphones) was dominated by multinational suppliers such as Samsung, Nokia and Sony.[2] 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.[3] Indian firm Micromax rose from a 5.6% share of the Indian smartphone market in 2012 to an estimated 15% in 2015, second only to Samsung, while Indian firms Intex and Lava rank third and fourth, respectively, in terms of market share.[4] 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 US$100, with a substantial share below US$40 or US$50.[5] Then, in February 2016, a virtually unknown Indian firm called Ringing Bells made international headlines when it announced the launch of its new bare bones "Freedom 251" smart

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[1] Telecom Regulatory Authority of India, The Indian Telecom Services Performance Indicators July – September 2015 at i (16 Feb. 2016), http://www.trai.gov.in/WriteReadData/PIRReport/Documents/Indicator_Reports.pdf [hereinafter TRAI Report 2016] (reporting 996.66 million wireless subscriptions as of Sept. 30, 2015).

[2] 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.

[3] Counterpoint Technology Market Research, India Surpasses USA to Become the Second Largest Smartphone Market in the World (Feb. 2, 2016), http://www.counterpointresearch.com/indiahandsetmarket2015 [hereinafter Counterpoint 2015], IDC, India's Smartphone Market Soars in the Second Quarter of 2015 with the Help of eTailing, Says IDC, Aug. 11, 2015, http://www.idc.com/getdoc.jsp?containerId=prSG25827215 [hereinafter IDC 2015 Report].

[4] IDC 2015 Report, *supra* note 3.

[5] Gartner Says Global Smartphone Sales to Only Grow 7 Per Cent in 2016, Mar. 31, 2016, http://www.gartner.com/newsroom/id/3270418, Smartphone Prices Race to the Bottom as Emerging Markets Outside of China Come into the Spotlight for Future Growth According to IDC, Feb. 24, 2012, https://www.idg.com/www/pr.nsf/ByID/MYAR-9GQNTU ("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.")

phone retailing for a mere Rs251 (US$4).[6] While there is skepticism about the viability of sub-$5 smartphones and even the authenticity of Ringing Bells' offer,[7], sub-$50 price points are clearly critical to the broad dissemination of mobile technology throughout India, where average income is far below Western levels.[8]

Domestic Indian mobile devices often cater to the local market, with local language apps and features.[9] 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 each other and from international competitors. Local Indian devices offered at less than US$100 have included models with oversized speakers, virtual piano keyboards, pico-projectors, multiple charging ports and multi-lingual capabilities.[10] This flourishing of local innovation is remarkable and is encouraged, we

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[6] 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/ [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

[7] 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.

[8] *See* IDC 2015 Report, *supra* note 3. According to figures published by the World Bank, gross national income per capita from 2011 to 2015 was US$ 1570 in India, US$ 55,200 in the US, and US$ 47,640 in Germany. World Bank, GNI per capita, Atlas method (current US$), http://data.worldbank.org/indicator/NY.GNP.PCAP.CD/countries

[9] The Freedom 251, for example, is advertised as including preinstalled apps relating to pet projects of the Modi administration, including womens' safety and the "Swachh Bharat" anti-litter initiative. $4 Smartphone, *supra* note 6.

[10] *See, e.g.,* United News India, Lava Launches Mobile Phone with 22 Indian Languages Support, pricing at Rs1500, 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, Jorge L. Contreras, Patent-Less Smartphone Innovation and Global Technology Markets, PatentProgress.org, Dec. 19, 2012, http://www.patentprogress.org/2012/12/19/patent-less-smartphone-innovation-and-global-technology-markets/#more-1356

hypothesize, by low entry barriers.[11]

In the developed world, the mobile device industry has been embroiled in patent infringement litigation for nearly a decade.[12] Multinational players such as Apple, Samsung, Google/Motorola, and Microsoft hold thousands of patents covering mobile devices and technology.[13] 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 are more aggressive in asserting them.[14] According to one estimate, an average smartphone in the U.S. is covered by approximately 250,000 different patents.[15] It has also been estimated that in 2013 alone, legal fees in these so-called smartphone wars reached US$1 billion.[16]

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.[17] And over the past three years, multinational telecommunications giant Ericsson has brought patent infringement suits against several Indian and Chinese handset vendors serving the domestic 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

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[11] These could include, for example, low 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.

[12] *See, e.g.*, Jorge L. Contreras, *The FRAND Wars: Who's on First*, Patently-O blog, Apr. 17, 2012.

[13] *See* Center on Law and Information Policy at Fordham Law School (CLIP), The Impact of the Acquisition and Use of Patents on the Smartphone Industry (Dec. 13, 2012) [hereinafter CLIP 2012 Study].

[14] CLIP 2012 Study, *supra* note 13, at x. *See also* Jorge L. Contreras, *Assertion of Standards-Essential Patents by Non-Practicing Entities* in PATENT ASSERTION ENTITIES AND COMPETITION POLICY (D. Daniel Sokol, ed. (Cambridge Univ. Press: 2016, forthcoming)).

[15] RPX Corp., Registration Statement (Form S-1), 59 (Sept. 2, 2011), *available at* http://www.sec.gov/Archives/edgar/data/1509432/000119312511240287/0001193125-11-240287-index.htm ("Based on our research, we believe there are more than 250,000 active patents relevant to today's smartphones . . . .")

[16] Mark Lemley, *Software Patents and the Return of Functional Claiming*, Stanford Public Law Working Paper No. 2117302 (Jul. 25, 2012), at n.92.

[17] Clairvolex, Inc., India's Patent Landscape in Communication Technology (2010), http://www.clairvolex.com/pdf/communication.pdf .

sector.[18]

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 a comprehensive patent landscape analysis of the mobile device sector in India. We collected and analyzed 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 I provides a brief history of the telecommunications market in India, charting the influence of foreign manufacturers and carriers on the market. Part I also includes a discussion of a range of humanitarian, public health and agricultural uses of mobile technologies in India and other developing countries. Part II.A provides an overview of the Indian patent system, focusing on its evolution in response to international pressures, particularly India's treatment of patents on pharmaceutical products. Part II.B discusses recent Indian patent infringement and competition litigation in the telecommunications sector. In Part III, we present the results of our patent landscape study of the Indian mobile device market. We conclude with recommendations for further study and policy.

I. 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 heavy governmental regulation and control toward open market competition. This shift has also seen the opening of India's telecommunications equipment markets to foreign competitors.

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[18] Soma Das & Anandita Singh Mankotia, *Patent Row: Delhi High Court Asks Micromax to Pay Royalty to Ericsson*, THE ECON. TIMES, (Nov. 20, 2014, 4:03 AM), http://articles.economictimes.indiatimes.com/2014-11-20/news/56304154_1_several-wireless-technology-standards-low-cost-business-strategy-digital-india.

1. Early Telecom Market Regulation

Following its Independence, India established governmental monopolies in a number of industries including telecommunications.[19] Foreign telecommunication firms were put under the control of the Posts and Telegraphs Department (P&T), a state-run monopoly,[20] and other private firms were prohibited from entering the market.[21] 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.[22]

By the early 1980s, Indian policy makers began to realize that its protective industrial system and excessive regulation had resulted in stagnation and inefficiency.[23] In the mid-1980s, the Indian government took a first step toward liberalizing the telecommunications sector by allowing private firms to manufacture terminal equipment.[24] Around the same time, the Indian government began to loosen import restrictions on electronics, computers, and telecommunications equipment.[25]

In the early 1990s, India experienced a severe economic crisis. Ultimately, India's economic downturn and the resulting economic liberalization opened up telecommunications to the private sector, boosting not only private investment and increased competition but also India's telecommunications infrastructure.[26]

Further changes to India's telecommunications sector were made in 1994 under the National Telecom Policy (NTP).[27] The NTP gave India's Department of Telecommunications (DoT) control over India's profitable long distance and international services.[28] Private firms were allowed access only to the local loop, which required significant capital investments in

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[19] Ramesh Subramanian, *The Continuing Evolution of India's Telecom Policy*, 8 QUINNIPAC UNIVERSITY SCHOOL OF BUSINESS 35 (2008), *available at* http://www.iima.org/CIIMA/7%20CIIMA%202008-8-3%20Subramanian%2033-48.pdf

[20] *Id.*

[21] *Id.*

[22] William Greene, *The Liberalization of India's Telecommunications Sector: Implications for Trade and Investment*, U.S. INT'L TRADE COMM'N 8 (Sept. 2004), *available at* http://ageconsearch.umn.edu/bitstream/15859/1/wp04009b.pdf.

[23] Subramanian, *supra* note 19, at 35.

[24] Greene, *supra* note 22, at 8.

[25] *Id.*

[26] *Id.*

[27] IBP USA, INDIA TELECOM LAWS AND REGULATIONS HANDBOOK 50 (2009).

[28] Subramanian, *supra* note 19, at 38.

fiber-optic cable.[29] Nevertheless, private firms were permitted to compete for other telecommunication services after meeting their obligations to the local loop arena.[30]

2. Mobile Services

Around this time, mobile telecommunication services in India were commercially launched.[31] In 1997 the Indian government established the Telecommunications Regulatory Authority of India (TRAI), an independent authority authorized to manage and regulate Indian telecommunications.[32] 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."[33]

In 1999, India adopted a New Telecom Policy (NTP 1999).[34] 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.[35] The NTP 1999 also included a number of specific targets relating to user base, access and density.[36] To achieve NTP 1999's ambitious goals, India's telecommunication regulations were amended to encourage private firms to enter the market.[37]

In 2000, the Indian government enacted the TRAI Amendment Act

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[29] *Id.*

[30] *Id.*

[31] IBP USA, *supra* note 27, at 51.

[32] *Id.* at 39. The TRAI can make recommendations to the DoT in areas specified under "Functions of Authority" in the TRAI Act, 1997: X.

[33] *History*, TELECOM REGULATORY AUTHORITY OF INDIA, http://www.trai.gov.in/Content/History.aspx.

[34] *Id.*

[35] *New Telecom Policy*, TELECOM REGULATORY AUTHORITY OF INDIA, http://www.trai.gov.in/Content/ntp_1999.aspx (last visited Mar. 5, 2015).

[36] *Id.* (The target goals of the NTP 1999 were, in part, to make telephone available on demand by 2002, to achieve a teledenisty of 7% by 2005 and 15% by 2010, to increase rural teledensity from .04% to 4% 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.)

[37] Subramanian, *supra* note 19, at 39.

of 2000[38] in an effort to revive India's stalled telecommunications sector. , The amendments stripped TRAI of its dispute resolution responsibility, and explicitly defined its role in areas such as wireless communications, quality standards, tariffs, and interconnection.[39] The Indian government also 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%. But in March 2000, the government reduced license fees for mobile service providers and increased the allowable stake for foreign companies to 74%.[40]

The most significant changes effected by NTP 1999 and the 2000 amendments were in the area of carrier tariffs.[41] First, operators shifted from having to pay up-front auction fees to revenue sharing.[42] However, the revenue sharing percentage was initially set too high, so the beneficial effects showed only after it was reduced from 15% to 8%.[43] NTP 1999 specified that the TRAI would recommend a tariff ceiling, and the TRAI order reduced cellular tariffs per minute from Rs. 16 to Rs. 6.[44] A second development affecting tariffs was the introduction of unregulated CDMA technology by private and public sector operators, and ensuing price competition.[45] A third factor affecting tariffs was the TRAI order in May 2003 concerning Calling Party Pays, which reduced tariffs by half.[46]

Together, these changes dramatically reduced the cost of wireless service and mobile phones, allowing large numbers of middle class families to afford mobile services for the first time.[47] This increased affordability, along with factors such as the expansion of wireless coverage throughout India, increasing per capita income and lowering call tariffs, has likely

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[38] *TRAI (Amendment) Act 2000*, TELECOM REGULATORY AUTHORITY OF INDIA, http://www.trai.gov.in/Content/Act2001.aspx.

[39] *Id.*.

[40] IBP USA, *supra* note 27, at 51.

[41] Shyam Ponappa, *Take 'Model T' for Telecom*, Business Standard, Dec. 2, 2010, http://www.business-standard.com/article/opinion/shyam-ponappa-take-model-t-for-telecom-110120200051_1.htmlX.

[42] Harsha Vardhana Singh, Anita Soni & Rajat Kathuria, Telecom Policy Reform in India, 2000, at 7 http://siteresources.worldbank.org/INTRANETTRADE/Resources/Singh.pdf

[43] Singh, at al, supra note 42, at x.

[44] Singh, at al, supra note 42, at 15.

[45] cite

[46] Telecom Regulatory Authority of India, Consultation Paper on Review of Interconnection Usage Charges, Apr. 27, 2011, http://www.trai.gov.in/WriteReaddata/ConsultationPaper/Document/cp-27apr2011.pdf.

[47] IBP USA, *supra* note 27, at 51.

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 per month.[48] By 2006, India had 65 million mobile subscribers.[49]

Further changes to India's mobile market occurred in 2007, when private cellular service providers persuaded the DoT to release unused spectrum from the Indian military.[50] The unused spectrum was assigned to firms on the basis of their number of subscribers. Licenses were to be made available on a first-come-first-served basis with a modicum of bundled spectrum.[51] 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.[52] India's mobile subscriber base has continued to grow since 2008. By September 2015, India had 997 million wireless subscribers, making it the world's second largest wireless market after China.[53] Alongside mobile subscriber growth, handset sales and mobile Internet growth have also increased substantially.[54]

B. Characteristics of the Indian Mobile Sector

India has historically lacked reliable and pervasive landline telephone infrastructure throughout large portions of its territory.[55] As a result, mobile services, which involve lower per line costs, quick deployment and reduced capital requirements, have surpassed landline telecommunications services

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[48] *Id.*

[49] *Id.*

[50] 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.

[51] Id.; Performance Audit Report on the Issue of Licenses and Allocation of Spectrum by the Department of Telecommunications (2010), http://www.cag.gov.in/sites/default/files/audit_report_files/Union_Performance_Civil_Allocation_2G_Spectrum_19_2010.pdf

[52] Subramanian, *supra* note 6, at 42.

[53] TRAI Report 2016, *supra* note 1, at i.

[54] *India's Mobile Phone Market*, IPSOS BUS. CONSULTING, http://www.ipsosconsulting.com/pdf/Research-Note-India-Mobile-Phone-Market.pdf (last visited Mar. 25, 2015).

[55] P. Jain & V. Sridhar, *Analysis of Competition and Market Structure of Basic Telecommunication Services in India.* 52 COMMUNICATIONS & STRATEGIES 271 (2003).

in India by a significant degree.[56] Thus, in September 2015, India had 996.66 million wireless subscribers, but only 25.95 million landline subscribers.[57] And among rural subscribers, approximately 4.77 million had landlines, while 418.84 million had wireless service.[58] The majority of Internet users in India access the Internet via mobile devices, while only five percent own personal computers.[59]

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.[60] The consumer handset market was initially dominated by multinational suppliers such as Samsung, Nokia and Sony.[61] It has only been over the past decade that domestic Indian handset manufacturers have gained increasing market share.[62] The Indian mobile handset market today consists of more than 150 competitors including Samsung (Korea), Indian firms such as Micromax, Intex and Lava, and Chinese firms such as Lenovo and Xiaomi.[63] 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.[64] Instead, most Indian handset vendors source hardware from assemblers and contract manufacturers located in China, Taiwan, Thailand and other jurisdictions,

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[56] *See id*., Raghbendra Jha & Sumit Majumda, *A Matter of Connections: OECD Telecommunications Sector Productivity and the Role of Cellular Technology Diffusion*. 11 INFORMATION ECONOMICS AND POLICY 243 (1999).

[57] TRAI Report 2016, *supra* note 1, at i.

[58] *Id*.

[59] Boston Consulting Group (BCG), The Mobile Revolution: How Mobile Technologies Drive a Trillion Dollar Impact 15 (2015).

[60] *See, e.g.,* John Ure & Araya Vivorakij, *Telecommunications and Privatisation in Asia*, in BUSINESS, MARKETS AND GOVERNMENT IN THE ASIA-PACIFIC 260 (Yun-Peng Chu and Rong-I Wu, eds. 1998), Hutchison Telecom, Press Release, Feb. 12, 2007, http://www.ckh.com.hk/upload/attachments/en/pr/1875_eng.pdf, Manan Kakkar, AT& Makes Another Attempt to Enter India, ZDNet, Mar. 12, 2013.

[61] Siddiqui, *supra* note 2.

[62] Counterpoint 2015, *supra* note 3, IDC 2015 Report, *supra* note 3.

[63] IDC 2015 Report, *supra* note 3.

[64] *See* Pervasive Technologies Book (forthcoming). *See also* Dieter Ernst, Upgrading India's Electronics Manufacturing Industry: Regulatory Reform and Industrial Policy, East-West Center Special Study, 2014 (Feb. 12, 2014), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2395030 (discussing India's historical and current lack of advanced manufacturing capability).

then load them with India-specific applications and package them for distribution and marketing in the Indian market.[65] 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.

C. Applications of Mobile Technology in India

In the United States and other western markets, smart phone and other mobile devices are typically viewed as tools for productivity enhancement and personal entertainment. Yet often overlooked are other important functions that mobile technologies can play in developing nations. In less developed countries, access to mobile technology has the potential to improve health, education, economic development and social welfare.[66] These functions are particularly important in countries that lack a pervasive and resilient wired telecommunications infrastructure. Thus, economist Jeffrey Sachs has referred to mobile technology as "the greatest tool for poverty alleviation ever invented."[67]

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, power lines) and the availability of medical aid and disaster relief.[68] Mobile communication also enables access to educational materials and government resources and supports the maintenance of familial and social networks.[69] Access to healthcare information and resources can significantly improve health monitoring, patient counseling and follow-up.[70] The capabilities of mobile

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[65] *Id*. at x.

[66] Jenny C. Aker & Isaac M. Mbiti, *Mobile Phones and Economic Development in Africa*, 24 J. ECON. PERSP. 207 (2010), Yongsoo Kim, Tim Kelly & Siddhartha Raja, Building Broadband: Strategies and Policies for the Developing World (The World Bank, Washington: 2010), Ahmed T. Rashid & Laurent Elder, *Mobile Phones and Development: An Analysis of IDRC-Supported Projects*, 36 ELEC. J. INFO. SYS. DEV. COUNTRIES (2009).

[67] BCG, *supra* note 59, at 20.

[68] Debanjan Das Deb, et al., *Coordinating Disaster Relief Operations Using Smartphone/PDA based peer to peer Communication*, 4 INT'L J. WIRELESS & MOBILE NETWORKS, December 2012.

[69] Rashid & Elder, *supra* note 66.

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

devices also enable a wide range of commercial activities, from simple online purchases to comparison shopping, job searching, banking, funds transfer, micro-lending, inventory management and tax collection.[71] In India, the app of popular online marketplace Flipkart enables Indian residents to shop and compare goods from thousands of vendors.[72] At a macroeconomic level, one comprehensive international study finds that mobile penetration has a direct impact on GDP growth.[73]

In this Part, we survey some important humanitarian and public health 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.[74] Some of these advances include medical appointment reminders, telemedicine, patient record access, treatment compliance measurement, health awareness, patient monitoring, and physician decision support.[75]

With the dramatic increase in mobile phone subscribers in India, the Indian government has taken steps to integrate and enhance health-related IT systems.[76] 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 services to pregnant women and children up to five-years old.[77] 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.[78] Pregnant mothers enrolled in the system can use MCTS to track what scheduled

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[71] Harald Gruber & Pantelis Koutroumpis, *Mobile Telecommunications and the Impact on Economic Development*, ECONOMIC POLICY, Jul. 2011, at 387.

[72] BCG, *supra* note 59, at 15. *See also* Rohini Lakshané, *The WhatsApp Economy*, Feb. 27, 2016, http://www.slideshare.net/CIS_India/rohini-lakshan-the-whatsapp-economy-27022016

[73] *Id*.

[74] Darrell West, *How Mobile Devices are Transforming Healthcare*, CENTER FOR TECH. INNOVATION 1 (May 2012), http://www.brookings.edu/~/media/research/files/papers/2012/5/22-mobile-health-west/22-mobile-health-west.pdf.

[75] *Id.* at 1.

[76] *India is the Second-Largest Mobile Phone User in the World*, GOV'T OF INDIA MINISTRY OF HEALTH & FAMILY WELFARE (Aug. 2, 2012), http://pib.nic.in/newsite/PrintRelease.aspx.

[77] *Id.*

[78] *Id.*

services they have received and what maternal care services they still require.[79]

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."[80]

2. Agriculture

Mobile technology advances have contributed significantly to India's agricultural sector, one of the most important segments of the Indian economy.[81] Mobile phones are being used to convey weather 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. [82]

India's Department of Agriculture & Cooperation (DoA&C) 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.[83] 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.[84] One farmer reportedly estimated that he increased his annual earnings by 25% "thanks to the farming and disease control techniques he learned from the service's regular messages."[85] Another farmer interviewed by Boston Consulting Group reported that he doubled his tomato yield by using the mKrishi mobile agriculture data app

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[79] *Id.*

[80] *Id.*

[81] Saravanan Raj & Suchiradipta Bhattacharjee, *Mobile Phone Applications for Agricultural Extension in India*, MOBILE PHONES FOR AGRICULTURAL EXTENSION: WORLDWIDE MAGRI INNOVATIONS & PROMISE FOR FUTURE 3 (Saravanan Raj, ed., 2014), http://www.saravananraj.net/wp-content/uploads/2014/12/27_Mobile-phones-for-Agricultural-Extension-in-India_Saravanan-Raj-Draft.pdf.

[82] Prashanthi Bonthu, *India and China: A Comparative Analysis of Mobile Phones in Agriculture*, UNIV. OF KANSAS 2 (2014), *available at* https://kuscholarworks.ku.edu/bitstream/handle/1808/14544/Bonthu_ku_0099M_13245_DATA_1.pdf;jsessionid=C30D48F0A4F766ABD5157FF26A280C14?sequence=1.

[83] Raj & Bhattacharjee, *supra* note 81. at 6–7.

[84] *Id.* at 8-10.

[85] 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/.

on his phone.[86]

Various other technologies have been developed to assist farmers in India. One such device is a phone-controlled water pump called a "Nano Ganesh."[87] The Nano Ganesh, which is relatively inexpensive, connects a farmer's mobile phone to his water pump.[88] The farmer can enter a code to start the water pump, even without regular cell phone service.[89] The Tata service allows farmers to send photos of diseased crops to experts directly from their phones and received feedback regarding appropriate remedial measures.[90] Another app, called "Tradersnet," is a virtual commodity exchange that connects producers and wholesale purchasers of coffee.[91] The app sends SMS messages to users' mobile phones every morning with offers and grades available for purchase that day. At the end of the day, users receive a text message with details of transactions actually effected.[92]

3. Personal Safety

A number of personal safety apps have been launched in India in response to highly publicized incidents of violence against women.[93] 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."[94]

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

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[86] BCG, *supra* note 59, at 20.
[87] *Id.*
[88] *Id.*
[89] *Id.*
[90] *Id.*
[91] *Id.*
[92] *Id.*
[93] 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/; *Fifteen Personal Safety Apps for Women*, THE TIMES OF INDIA (Dec. 9, 2014), http://timesofindia.indiatimes.com/tech/slideshow/15-personal-safety-apps-for-women/itslideshowviewall/45431568.cms (describing fifteen different safety for women in India).
[94] *Id.*

distress.[95] Similar apps have been introduced in other Indian cities. In addition to personal safety apps like these, India's finance ministry has approved proposals to streamline police, mobile, and legal services in India.

4. Disaster Response and Relief

Mobile technology has increasingly been used to improve disaster response and humanitarian aid in India and around the world.[96] For example, during severe flooding in Chenai in 2015, relief efforts were coordinated via Twitter and Facebook.[97] Crowdsourcing was used to map flooded roads and relief sites, and to channel relief and rescue efforts to the most critical areas.[98] As one relief worker commented, "the Internet is our lifeline now."[99] Similar efforts helped to locate stranded persons and improve crisis response during flooding in Uttarakhand in 2013.[100]

In addition to these 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.[101] This technology can enable communication during natural disasters when traditional communication networks have been disabled.[102] AT&T has launched a public safety challenge that allows mobile app developers to submit applications to improve emergency services' response to disasters.[103] 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.[104] Apple has a new section in its App Store called "Stay in Touch." It provides several disaster-relief applications: The American Heart Associations' *Pocket First*

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[95] *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.

[96] Darrell M. West & Elizabeth Valentini, *How Mobile Devices are Transforming Disaster Relief and Public Safety*, CENTER FOR TECH. INNOVATION 1 (July 2013), *available at* http://www.insidepolitics.org/brookingsreports/Disaster%20Relief.pdf.

[97] *See* 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

[98] *Id*.

[99] *Id*.

[100] *See* Google Crisis Response, 2013 Uttarakhand Flooding, http://google.org/crisismap/2013-uttrakhand-floods?gl=in.

[101] West & Valentini, *supra* note 96, at 2.

[102] *Id.* at 3.

[103] *Id.*

[104] *Id.*

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.[105]

II. 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.[106] As such, India offered relatively strong patent protection for domestic and foreign products.[107] In 1970, however, India radically amended its Patent Act, substantially limiting the availability of patents on several product categories including drugs, but continuing to protect the processes used to make them.[108]

The Indian Patent Office (IPO) has administrative authority to examine and grant patents in India. The IPO falls within the Department of Industrial Policy and Promotion (DIPP), a department of the Ministry of Commerce and Industry.[109] Oversight of the IPO is delegated by DIPP to the Controller General of Patents, Designs and Trade Marks.[110] Despite statutory requirements concerning prompt action on patent applications, the IPO has been criticized recently for the excessive 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.[111] The IPO has begun to consider

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[105] *Id.* at 4.

[106] KALYAN C. KANKANALA, ARUN K. NARASANI & VINITA RADHAKRISHNAN, INDIAN PATENT LAW & PRACTICE 1 (2010).

[107] P. NARAYANAN, PATENT LAW 5 (4th ed. 2006). *See also* SRIVIDHYA RAGAVAN, PATENT AND TRADE DISPARITIES IN DEVELOPING COUNTRIES 31-32 (2016) (summarizing history of Indian patent law).

[108] The Patents Act § 5, No. 39 of 1970, INDIA CODE (1970). *See* RAGAVAN, *supra* note 107, at 42-45 (summarizing changes effected by the 1970 law).

[109] KANKANALA, NARASANI & VIITA RADHAKRISHNAN, *supra* note 106, at 8.

[110] *Id*.

[111] *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.

various administrative reforms to address this problem.[112]

For historical, cultural and political reasons, India has generally adopted an abstemious posture toward patent protection. India did not recognize patents on pharmaceutical products or processes until 2005,[113] and still declines to issue patents on software inventions.[114] Nevertheless, India has issued a sizeable number of patents, with nearly 50,000 patents in force as of 2014, ranking 22nd in the world.[115]

As a member of the World Trade Organization since 1995, India is a party to the WTO agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS).[116] 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 requirements, controversy remains surrounding India's implementation of these statutory requirements, as discussed in the next Part.

2. The Debate over Compulsory Licensing

One of the most significant areas of controversy surrounding India's patent law is compulsory licensing. Despite India's recognition of pharmaceutical products as patentable subject matter in 2005, India has remained open to potential compulsory licensing of patents necessary for

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[112] *See, e.g.*, K.L. Vahehra and 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; Madhur Singh, *India Aims to Decide Patent Applications in 18 Months*, Bloomberg Law, Apr. 27, 2016.

[113] KANKANALA, NARASANI & VIITA RADHAKRISHNAN, *supra* note 106, at 2.

[114] Office of the Controller General of Patents, Designs and Trade Marks, Guidelines for Examination of Computer Related Inventions (CRIs) at 13 (Feb. 19, 2016) (excluding "mathematical methods or business methods or computer programme per se or algorithms" from patentability).

[115] World Intell. Prop. Org. (WIPO), Statistical Country Profiles – India, http://www.wipo.int/ipstats/en/statistics/country_profile/profile.jsp?code=IN (visited Mar. 24, 2016). The United States, in comparison, had more than 2.5 million patents in force in 2014, ranking first among countries. World Intell. Prop. Org. (WIPO), Statistical Country Profiles – United States of America, http://www.wipo.int/ipstats/en/statistics/country_profile/profile.jsp?code=US (visited Mar. 24, 2016).

[116] WTO Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), Annex 1C of the Marrakesh Agreement Establishing the World Trade Organization, signed in Marrakesh, Morocco on 15 April 1994.

the production of pharmaceutical products.[117]

Article 30 of the TRIPS Agreement permits a member state to allow exceptions to the exclusive rights of a patent holder. 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."[118] The 2001 Doha Ministerial Declaration on TRIPS and Public Health ("Doha Declaration"),[119] clarified that the manufacture of drugs for use in a country need not occur in that country, paving the way for countries such as Brazil and India to develop generic drug industries serving various export markets.[120]

Section 84 of the Indian Patents Act authorizes an Indian manufacturer to apply to the Controller General of Patents 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.[121] Several other provisions for compulsory licensing also exist in the Patents Act.[122]

In 2012, the Controller General of Patents 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% royalty to Bayer.[123] The compulsory license was upheld by the Indian Intellectual

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[117] *See, generally*, Omar Serrano & Mira Burri, *Making Use of TRIPS Flexibilities: Implementation and Diffusion of Compulsory Licensing Regimes in Brazil and India*, World Trade Inst. Working Paper No. 1 at 9-10, Mar. 2016, http://www.wti.org/media/filer_public/2a/ce/2acebafa-e64b-4276-93da-064e9a2d7caf/serrano_burri_book_chapter_wp.pdf, Jodie Liu, *Compulsory Licensing and Anti-Evergreening: Interpreting the TRIPS Flexibilities in Sections 84 and 3(d) of the Indian Patents Act*, 56 HARV. INTL. L.J. 207 (2015).

[118] TRIPS Agreement, *supra* note 116, at art 31(b).

[119] World Trade Organization, Ministerial Declaration of 20 November 2001, WT/MIN(01)IDEC/2 (2001).

[120] *See* RAGAVAN, *supra* note 107, at 73, 90-94.

[121] Patents Act (1970) § 84(1). *See, generally*, Liu, *supra* note 117, at 215-17 (discussing requirements of § 84(1) in detail).

[122] Patents Act (1970) §§ 80, 92 and 92A. *See* RAGAVAN, *supra* note 107, at 121-22.

[123] Natco Pharma. Ltd. v. Bayer Corp., Compulsory License Application No. 1/2011 (Controller of Patents, Mumbai, Mar. 9, 2012), http://www.ipindia.nic.in/ipoNew/compulsory-License_12032012.pdf .

Property Appellate Board, but with an increase of the royalty to 7%.[124] The issuance of this compulsory license gave rise to significant opposition from the western pharmaceutical industry.[125]

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.[126] And this year, an application for compulsory license by Lee Pharma, an Indian generic drug manufacturer, was rejected with respect to BMS's diabetes drug Saxagliptin.[127] Nevertheless, the Indian government has recently reiterated its position that compulsory licenses remain available in suitable cases.[128]

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 government suggests that compulsory licenses may be available when patent holders are unwilling to license, or to charge reasonable rates

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

[125] *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/

[126] *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 (Feb. 4, 2016) (application rejected largely on procedural grounds).

[127] 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 126, at 7-9.

[128] *See* Alex Lawson, *India Won't Cease Controversial Drug Licensing Policy*, Law360, Mar. 24, 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").

for, patented green technology.[129]

The United States Trade Representative (USTR) has expressed concern regarding India's position with respect to compulsory licensing of patents in the areas of pharmaceuticals and green technologies, among other things.[130] As a result of these concerns, the USTR has, for the past several years, placed India on its Priority Watch List.[131] Nevertheless, India has recently adopted measures intended to improve its status in the eyes of foreign governments, including the adoption in 2016 of a National Intellectual Property Rights Policy making numerous assurances regarding India's respect for and intention to enforce intellectual property rights vigorously.[132] It is not clear whether these measures have alleviated the concerns either of the USTR or private interests in the west.

B. The Smart Phone Wars Reach India

Unlike India's generic drug industry, which has thrived since the 1970s,[133] India's domestic mobile technology market is relatively young. As noted above, India did not play a significant role in the so-called "smart phone 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

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[129] 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 . 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)).

[130] Ambassador Michael B.G. Froman, *2015 Special 301 Report*, OFFICE OF THE U.S. TRADE REP. 49-50 (2015), https://ustr.gov/sites/default/files/2015-Special-301-Report-FINAL.pdf [hereinafter Special 301 Report 2015] (also criticizing the difficulty that firms have obtaining injunctions to prevent ongoing patent infringement and numerous inefficiencies at the IPO).

[131] *Id*. at 45-46.

[132] Govt. of India – Ministry Commerce & Indus., National Intellectual Property Rights Policy (May 12, 2016), http://dipp.gov.in/English/Schemes/Intellectual_Property_Rights/National_IPR_Policy_12.05.2016.pdf.

[133] *See* Liu, *supra* note 117, at x.

most western technology firms in the domestic Indian market. Nevertheless, over the past three 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 numerous Indian patents covering both standardized and non-standardized features of mobile telecommunications devices and infrastructure. Its first Indian infringement suit was brought 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.[134] In 2013, the Delhi High Court ruled in Ericsson's favor, ordering Kingtech to refrain from importing devices infringing the AMR patents.[135]

Beginning in 2013, Ericsson began to assert a larger group of eight patents including its five AMR patents, as well as 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).[136] Though many of these cases remain subject to further proceedings and appeal, 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

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[134] Televonaktiebolaget LM Ericsson v. Kingtech Elecs., CS(OS) 68/2012, High Court of Delhi, Order, Aug. 22, 2013, http://delhihighcourt.nic.in/dhcqrydisp_o.asp?pn=163228&yr=2013

[135] *Id*.

[136] For an in-depth discussion of these actions, *see, e.g.,* Rohini Lakshané, Compilation of Mobile Phone Patent Litigation Cases in India, http://cis-india.org/a2k/blogs/compilation-of-mobile-phone-patent-litigation-cases-in-india, J. Gregory Sidak, *FRAND in India: The Delhi High Court's Emerging Jurisprudence on Royalties for Standards-Essential Patents*, J. INTELL. PROP. L. & PRACTICE, Jun. 12, 2015; Kirti Gupta, FRAND in India: Emerging Developments, Antitrust in Emerging and Developing Countries, Conference Papers (2016).

importation of infringing products into India.[137]

2. Vringo's Indian Patent Assertion Suits

Vringo, Inc. 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."[138] 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[139] and Taiwanese PC manufacturer Asus Computer.[140] 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.[141] Vringo prevailed in its Indian action against ZTE;[142] its suit against Asus is still pending in the Delhi High Court.[143]

3. Competition Commission Investigations

In response to Ericsson's patent infringement suits, several defendants have challenged Ericsson's conduct under Indian competition law.[144] The first such action was initiated by Micromax in 2013 with a complaint filed

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[137] *See* Lakshané, *supra* note 136, Sidak, *supra* note 136.

[138] Vringo, Inc., About Us, http://www.vringoip.com/cgi-bin/about.pl. One of the authors (Contreras) filed an Affidavit in support of Vringo in its Brazilian litigation with ZTE.

[139] Vringo Infrastructure Inc. v. Indiamart Intermesh Ltd., Delhi High Ct. No. 2112/2014 (Aug. 5, 2014).

[140] Vringo Infrastructure Inc. v. Nuage Techsol Pvt. Ltd., Complaint, Delhi High Ct. (Apr. 14, 2014).

[141] *See, e.g.*, Jack Ellis, *Vringo and ZTE Go the Distance: An Infographic*, Intell. Asset Mgt. Blog, Dec. 15, 2015, http://www.iam-media.com/blog/Detail.aspx?g=fe946e60-87b7-4840-81fd-0513a847aa51 (describing litigation between Vringo and ZTE in 12 different jurisdictions).

[142] Vringo Infrastructure Inc. v. Indiamart Intermesh Ltd., Delhi High Ct. No. 2112/2014 (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*, IAM Blog, Dec. 8, 2015, http://www.iam-media.com/blog/detail.aspx?g=16c03b05-cd13-46c3-9e55-eb0a57c99a57

[143] *See* Lakshané, *supra* note 136.

[144] For an overview of the theories asserted in such actions, *see* Sidak, *supra* note 136, and Shubha Ghosh & D. Daniel Sokol, FRAND in India (Jan. 26, 2016), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2718256

with the Competition Commission of India (CCI).[145] The complaint alleged that Ericsson violated the Indian Competition Act[146] through abuse of its patent-conferred dominant position.[147] 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."[148] The CCI issued a preliminary order finding evidence that Ericsson abused a dominant position created by its standard-essential patents, and ordered a full investigation by the Director General.[149] Similar competition claims against Ericsson were brought by Intex[150] and iBall.[151]

III. THE MOBILE DEVICE PATENT LANDSCAPE IN INDIA

In order to gain a better understanding of the patent landscape of the mobile device market in India, we conducted a detailed study of filed applications and issued patents in a selected set of industry classes. In this Part we present our methodology and results, as well as a summary of other recent studies that informed our analysis.

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[145] Competition Comm'n India, Order - Micromax Informatics Ltd, CCI Case No. 50, Para. 8, at 4.

[146] Competition Act 2002, § 4, No. 12, Acts of Parliament, 2003.

[147] Competition Comm'n India, Order - Micromax Informatics Ltd, CCI Case No. 50, Para. 8, at 4.

[148] Such "FRAND" commitments are commonly made by participants in standard-setting organizations. *See, e.g.*, Sidak, *supra* note 136.

[149] Micromax, CCI Case No. 50, Para. 19, at 8. The investigation was suspended for more than two years after Ericsson petitioned the Delhi High Court to intervene. High Court of Delhi, W.P No. (C) 464/2014. Court vide order, 21st January, 2014. However, the High Court has recently permitted the investigation to resume. High Court of Delhi, W.P. No. (c) 464/2014, Judgment, 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. However, it also noted that the scope of enquiry under the Competition Act would be restricted to determining whether there has been abuse of dominant position. *Id*.

[150] Intex Technologies Ltd. v. Ericsson, Competition Commission of India, Case No. 76/2013 (Jan. 16, 2014). *See, generally,* Dept. Industrial Policy & Promotion (DIPP), Discussion Paper on Standard Essential Patents and their Availability on FRAND Terms at 24 (Mar. 1, 2016).

[151] Best IT World (India) Pvt. Ltd. v Telefonaktiebolaget LM Ericsson, CCI Case No. 4 of 2015, Competition Comm'n of India (12 May 2015), http://www.cci.gov.in/May2011/OrderOfCommission/261/042015.pdf. *See, generally*, DIPP Discussion Paper, *supra* note 150, 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 Times, Nov. 20, 2015, http://www.thehindubusinessline.com/info-tech/iball-ericsson-settle-patent-issue/article7900713.ece

A. Prior Studies

1. General (Global) Studies

Several general studies of the patent landscape in the mobile telecommunications sector have 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).[152] The CLIP study identified thirty-seven key market participants and their relevant market shares, patent holdings, publicly available licenses and information regarding litigation. Data were compiled from a combination of public sources and targeted surveys.

A more narrowly-focused study of the global patent landscape relating to 4G-LTE technology was conducted by market research firm iRunway in 2012.[153] 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.[154] Approximately 2,440 such patents were identified in various technical categories.

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.[155] Using a subsystem-based analysis, they estimated that a hypothetical US$400 smartphone would be subject to patent royalties (disregarding any cross-licensing reductions) in excess of US$120. Also in 2014, the European Commission published an extensive report analyzing the impact of patents on technical standards, a significant component of which was

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[152] CLIP 2012 Study, *supra* note 13.

[153] 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

[154] Nehaa Chaudhari, Mobile Phone Patents: Prior Art Survey (Oct. 23, 2013), http://cis-india.org/a2k/blogs/mobile-phone-patents .

[155] Ann Armstrong, Joseph J. Mueller & Tim Syrett, The Smartphone Royalty Stack: Surveying Royalty Demands for the Components Within Modern Smartphones (May 29, 2014), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2443848 .

devoted to the mobile telecommunications sector.[156]

2. India-Focused Studies

These recent 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.[157] 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 top filers of Indian patent applications in telecommunications-related technology classifications and charts 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 below.[158]

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

Clairvolex "key player"	**Nationality**	**Number of Indian telecom patent applications held**
Qualcomm	USA	1951
Ericsson	Sweden	1232
Samsung	Korea	1103
Nokia	Finland	1154
Motorola	USA	626
RIM/Blackberry	Canada	558
LG	Korea	626
Sony-Ericsson	Japan	363

[156] European Commission, Patents and Standards – A Modern Framework for IPR-Based Standardization at Ch. 3.1 (2014).

[157] Clairvolex, *supra* note 17.

[158] 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.

These findings are consistent with statistics reported by the World Intellectual Property Organization (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%) were issued to domestic Indian firms, while 5,433 were issued to non-Indian firms.[159] Likewise, of a total of 42,854 patent applications filed in India in 2014, 12,040 (28%) were filed by domestic Indian firms, while 30,814 (72%) were filed by non-Indian firms.[160] These statistics, while supporting the earlier study's finding that all major holders of Indian patents in the telecommunications field, 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%) and organic chemistry (18.10%). Computer technology applications represented only 14.31% of the total, while "digital communication" patent applications constituted a mere 3.59% 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, while Indian firms may hold far fewer patents in the field of mobile telecommunications.

Given that the Clairvolex study was conducted in 2010, prior to the emergence of a significant domestic Indian mobile device industry, because it provides no information regarding the "low end" of the patent holding spectrum (i.e., below the top eight foreign "key players"), and because it was based on proprietary data and search methodologies, we have updated these findings with the new, more comprehensive and publicly-accessible data described below.

B. Methodology

In order to assess the Indian patent landscape relating to mobile devices, we developed a search strategy utilizing Indian Patent Office (IPO) records of issued patents and published patent applications.[161] We elected to access and search these records as they exist in the Derwent World Patent Index (DWPI) made available through Thomson Innovation (TI),[162] as this

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[159] WIPO – India Statistics, *supra* note 115 (Patent Grants).

[160] WIPO – India Statistics, *supra* note 115 (Patent Applications).

[161] Indian patent applications are published 18 months after filing. *See* KANKANALA, NARASANI & VIITA RADHAKRISHNAN, *supra* note 106, at 66-67.

[162] http://www.info.thomsoninnovation.com/sites/default/files/assets/L-367541.pdf . Access to the DWPI through Thomson Innovation is available to the public for a fee.

database offers additional data (such as assignee records), front end tools, searching and access that is superior to the electronic records of the IPO itself. The DWPI database contains editorially enhanced titles and abstracts of issued Indian patents from January 1, 2000 and published Indian patent applications from 2005.

To execute the relevant searches and compile the results, we engaged a commercial patent searching firm in India familiar with the DWPI system. We informally interviewed leading Indian patent law firms to compile a list of reputable patent search firms from different parts of India. We then solicited written bids from ten of these search firms. Responses included a description of the firm's experience and qualifications, a proposed work plan and timetable, and a price quotation. Based on these responses, we selected two independent firms to perform searches for this study. During the course of the study, the performance of one of the selected firms became unacceptable, leaving us with a single firm (Hourglass Research, Mumbai, India) to perform the bulk of the searching tasks, which were performed at an acceptable level.

The search firm constructed search queries based on a list of fifty leading Indian and non-Indian firms in the mobile telecommunications 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, as well as local listings of top mobile device vendors in the Indian market. A taxonomy of mobile device systems and subsystems was then developed (see Appendix B).

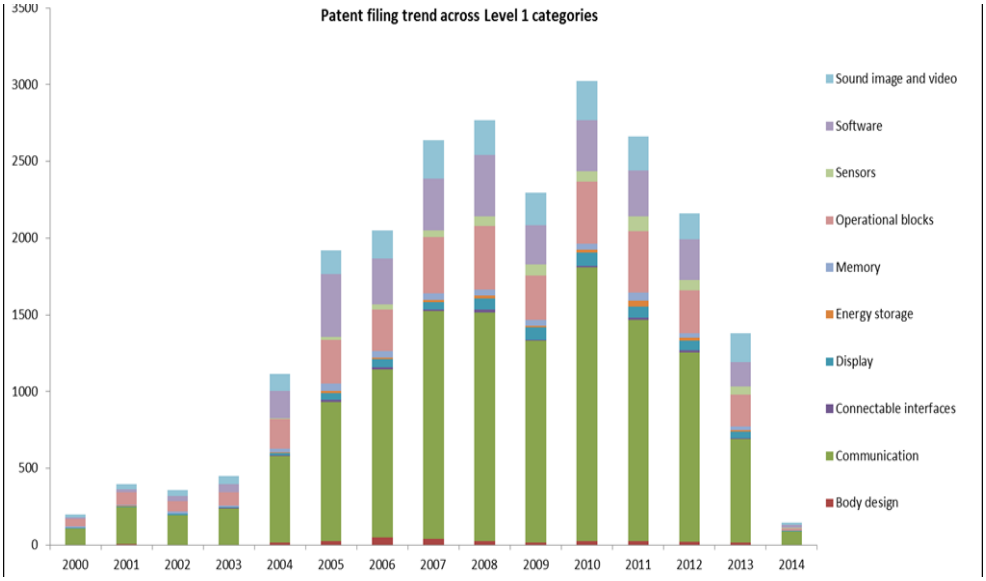
The DWPI database was queried in February 2015 using a series of text-based search strings that combined keywords relating to mobile device technology, International Patent Classification (IPC) codes and the names of targeted firms. The published patent applications and issued patents that were identified 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 CIS web site.[163]

[163] http://cis-india.org/a2k/blogs/dataset-patent-landscape-of-mobile-device-technologies-in-india.

C. Findings

We identified a total of 19,569 published Indian patent applications and 4,052 issued Indian patents relating to mobile devices from January 2000 through February 2015.[164] Table 2 below illustrates the breakdown of these patents into ten high-level technology categories, organized by year of filing.[165]

Table 2
Patent Applications by Year and Technology Category



The single technology category with the greatest number of patents was communications (12,857), which was broken into nine distinct sub-categories (see Appendix B). We found 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.[166]

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

[165] A significant lag exists in the recognition of patents for 2013 and 2014, given the 18-month delay in publishing these applications.

[166] 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), Sec. 3 (prohibiting patenting of various computer-related inventions), Office Controller of Patents, Designs and Trademarks, Guidelines for Examination of Computer Related Inventions (CRIs) (Feb. 19, 2016).

Table 3 sets out the top eleven holders of patents by this search.[167] Consistent with the results of prior studies, all of these entities are non-Indian, based in North America, Europe and the Asia-Pacific region.

Table 3
Indian Patents and Applications in the Telecommunications Patents Top Assignees (2000-2015)

Assignee	Nationality	Total Published Indian Applications and Issued Patents
Qualcomm	USA	5,954
Ericsson	Sweden	1,843
Samsung	Korea	1,827
Nokia[168]	Finland	1,744
Microsoft	USA	1,557
Philips	Netherlands	1,460
Sony	Japan	1,235
Alcatel-Lucent	France	971
Motorola	USA	842
LG	Korea	791
RIM/Blackberry	Canada	782

While Table 3 presents data relating to the top eleven holders of Indian patents, we compiled patent ownership data for all fifty entities listed in Appendix A. Of these, thirty-eight were non-Indian and twelve were Indian.

[167] 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.

[168] Many Nokia patents are now held by Vringo. *See* Vringo, Inc., News Release – Vringo Announces Fourth Quarter and Year End Results for 2012 (Mar. 21, 2013), http://www.vringoip.com/cgi-bin/news.pl (announcing acquisition of portfolio of more than 500 patents from Nokia).

Of approximately 23,500 total patents identified, a total of only *eighteen* patent applications and 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 at all.[169]

In a follow-up search, we queried the IPO online database on April 1, 2016 for patents and patent applications held by the twelve Indian firms in our original search plus nineteen additional Indian mobile device producers.[170] No additional patent applications or issued patents were identified. However, for the period following our original search window, we identified 55 new published patent applications by Indian firm HCL.

We also searched for patents held by Indian "value added service" vendors in the telecommunications sector (Level 1 of the Software category shown in Appendix B). We identified 10 patent applications held by Comviva, 21 patent applications held by MobMe, and 20 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 revealed by this study 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 eleven top Indian patent holders in this study appear toward the top CLIP's list of thirty-seven top global telecom patent holders.[171] 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

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[169] See Appendix A.

[170] See Appendix C.

[171] CLIP 2012 Study, *supra* note 13, at App. IV. One exception is Philips, which, while listed in CLIP's list of top 37 patent holders inexplicably does not appear in Appendix IV of the CLIP study report, which only lists 35 firms.

be made in PCT member countries such as India (particularly given that India's official language for filing is English).[172]

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? Some might suggest, as they have in the context of the Indian generic pharmaceutical industry, that Indian firms are not innovative and simply wish to copy technologies developed elsewhere. But this naïve characterization is both 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.[173] And based on our 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.[174] Thus, a lack of innovation is likely not the cause for the absence of patenting by Indian firms.

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 a general lack of faith in the Indian patent system coupled with a realization that short product cycles combined with lengthy patent prosecution delays[175] may result in patents that, once issued, have little commercial value (i.e., as they may cover only previous generations of products).

Finally, cost may play a role in the unwillingness of Indian firms to pursue patent protection in the telecom 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 from US$100 down to the extreme of Ringing Bells' US$4.00 price point. At these rock bottom prices, profit margins are likely thin to non-existent,

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[172] *See* KANKANALA, NARASANI & RADHAKRISHNAN, *supra* note 106, at Ch. 11.

[173] *See, e.g.,* US-India Business Council, The Value of Incremental Pharmaceutical Innovation: Benefits for Indian Patients and Indian Business 2 (2009), http://www.indiaenvironmentportal.org.in/files/USIBCIncrementalInnovationReportFinal.pdf

[174] *See* Contreras, *supra* note 10.

[175] *See* notes 111-112, *supra* (discussing patent prosecution delays of 8-9 years).

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. There are inherent limitations in what such quantitative data can reveal. Thus, 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 would include surveys and direct interviews with individuals involved in the Indian mobile device market.

Another area of potential 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,[176] 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.

CONCLUSIONS

India is the world's second largest mobile communications market. Though it has remained largely unaffected by the smart phone wars that affected much of 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,

[176] *See, e.g.*, Ghosh & Sokol, *supra* note 144, at 5.

health and economic benefits afforded by mobile technologies.[177] 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 the authors and others. One of the authors (Lakshané), together with the Centre for Internet and Society (CIS), have 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% of the end product's net selling price.[178] Contreras, in connection with the National Science Foundation's 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 to improve their bargaining posture with technology incumbents.[179] Other scholars have proposed additional mechanisms for equalizing disparities in patent holdings among firms in developing and developed countries.[180]

While 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.

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[177] *See* Part I.B, *supra*.

[178] Rohini Lakshané, Letter to Prime Minister Shri Narendra Modi, Mar. 24, 2015, http://cis-india.org/a2k/blogs/open-letter-to-prime-minister-modi

[179] Jorge L. Contreras, *Patents, Standards and Borders: Addressing National Disparities among Holders of Standard-Essential Patents* (Jan. 27, 2016), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2726237##

[180] *See, e.g.,* Florian Ramel, Maximlian von Laer & Knut Blind, Standard Essential Patents and the Distribution of Gains from Trade for Innovation (Mar. 2016), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2745496

APPENDIX A

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

Assignee	Nationality	Patents and patent apps
Qualcomm	USA	5954
Ericsson	Sweden	1843
Samsung	Korea	1827
Nokia	Finland	1744
Microsoft	USA	1557
Philips	Netherlands	1460
Sony	Japan	1235
Alcatel Lucent	France	971
Motorola	USA	842
LG	Korea	791
Research in Motion/ Blackberry	Canada	782
Panasonic	Japan	537
NTT Docomo	Japan	523
Huawei	Japan	470
Siemens	Germany	366
Intel	USA	331
ZTE	China	303
InterDigital	USA	288
Apple	USA	256
Hewlett-Packard	USA	225
NEC	Japan	209
IBM	USA	203
Cisco	USA	165
Google	USA	132
Fujistu	Japan	89
Canon	Japan	87
Hitachi	Japan	84
Yahoo	USA	70
Oracle	USA	59

Assignee	Nationality	Patents and patent apps
Toshiba	Japan	36
AT & T	USA	23
SAP	Germany	22
ETRI	Korea	21
Broadcom	USA	17
Nortel	Canada	17
Texas Instruments	USA	12
HCL	India	11
Spice Digital	India	6
Videocon	India	1
HTC	Taiwan	0
Sprint	USA	0
Karbonn	India	0
Intex	India	0
Lava	India	0
Micromax	India	0
Xolo	India	0
Datawind	India/Canada	0
Salora International	India	0
Simmtronics	India	0
Onida	India	0

Total 23569

APPENDIX B

Taxonomy With Categorization and Sub-categorization of Patents

Level 1	Level 2	Patents and Apps	Description
Communication		12857	
	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	2857	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, 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 specific aspects specific to mobile telephone networks. Includes selection transmission modes
	Call and data management	3830	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 | Monitor redundancy and bit error rate (BER); various coding schemes such as block codes and convolutional codes; interleaving; turbo codes and puncturing.
	Bandwidth control and optimization	2414	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); 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 quality and reliability of wireless link.

Level 1	Level 2	Patents and Apps	Description
	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 use 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		3407	
	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 through antenna; equalisers; phase-locked loops (PLL) and DLL; 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	1115	Includes all radio electronic components and is connected to the RF transceiver. Responsible for processing received analog signals from the RF transceiver. Generating and transmitting pre-coding matrix.
	Power Management	269	Techniques of power management in mobile phones and 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 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)

Level 1	Level 2	Patents and Apps	Description
			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. Examples: CMOS and CCD sensors
			System for processing and conditioning data received from camera sensor. May include systems for image stabilization and exposure control.
			Sensor assembly to implement zoom levels, 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
Sound, image and video		2132	
	Audio and video processing	1512	Audio sensor such as microphone to sense audio of 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, 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
	Display protection	2	Different types of display protection such as Gorilla Glass 3 or sapphire protective glass
Software		3068	

Level 1	Level 2	Patents and Apps	Description
	Basic phone applications	3068	Includes functions performed by the operating system (OS) of the phone such as displaying of text messages, searching, file management, ringtone management, etc.
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 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 (made in China, imported into India by Indian e-commerce venture Flipkart)
11 Swipe Telecom
12 Obi Mobiles
13 MTS
14 AirTyme Communications
15 YU Televentures
16 Zync
17 Ringing Bells
18 Lyf
19 Beetel